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JANUARY 1958

Action for Safety
Urban Expressway Planning
How Road-Users Appraise Roads
Accident Causes: U. S. Experience
Controlled-Access and Land Economics
Regional Effects of Urban Highways
Comprehensive Transport Planning
Safety for Emergency Vehicles
The Massachusetts Turnpike
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Action for Safety

As we embark on our thirteen-year Federal road building program, many citizens indicate an unusual interest in the 40,000-mile project's contribution to safety in motor travel.

Because of the size and extent of the undertaking, directly affecting many persons in multiple ways, discussions of the program arise in various areas, on such different facets as economics, land uses, population shifts – and safety.

The public, partly aware of the high design standards, cannot *interpret* them in terms of *safety*. This emphasis is due to their familiarity with our annual records of deaths and accidents.

Some predictions from reliable sources have been made. One is that with the expenditure of forty-six percent of the funds on interstate roads on the completion of 40,000 miles in the projected construction period of thirteen years, there will be an annual saving of 4,000 lives. This prediction is based on experience on roads of similar design to those contemplated for the interstate system.

These prophecies appear reasonable as it is known that controlled-access roads contribute to safe driving. On this basis, should all other facts remain unchanged, we may at the end of thirteen years expect a ten percent decrease in driving fatalities.

During the period of 1944 to 1956 inclusive, the death rate per 100 million miles of travel by scheduled air transport dropped from 2.1 to 0.62. In the same period the death rate per 100 million miles of vehicle travel dropped from 12 to 6.4. This is a benevolent way of expressing encouragement in the face of our serious concern.

A difficult problem in forecasting is the absence of compatible and reliable records of past experience and performance. This is due mainly to their promiscuous origin, diversity of traffic control measures, and various interpretations of judicial notice.

In other fields, the state of efficiency of our traffic control might well be labeled mismanagement.

Our experience with air travel in the last thirteen years offers a contrast worth notice.

In this period, airlines have made phenomenal progress in their safety records. While the two modes of travel do not suggest direct

comparison, a study of their methods should prove profitable. Much of the safety improvement is due to efficient operation, competition, positive controls, and a consciousness of safety impossible to slight without ruinous consequences.

A notable measure of airline success is the transformation of passengers' former fear to a feeling of trust.

Any meaningful discussion of safety must look to responsible sources for corrective measures. Tolerance has brought the situation into public focus. The public would welcome, we believe, severe corrective measures for offenders if not accompanied with an unnecessary nuisance effect on the *safe*-driving public.

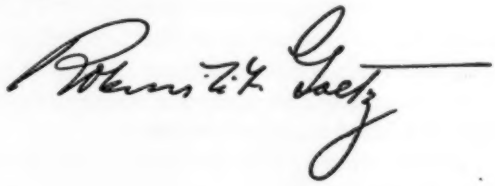
Over a long period, states have made an unsuccessful effort to bring the disparities of nationwide traffic control into a semblance of uniformity.

The heads of our states have highly trained specialists to guide them in their deliberations and actions, with greater assurance of agreement without infringement on their recognized authority within the states.

Yet annual records of driving fatalities are repeatedly discouraging and show little sign of improvement or encouraging progress, but increasing signs of public impatience.

There have been instances of isolated action, well-meant, but ill-advised, resulting in failure to spur a following. Nothing less than the full concurrence of all heads of states and their enthusiastic support of appropriate traffic-control measures will awaken the public or win its acclaim.

The problem is national. It deserves highest consideration, prompt and dauntless action. The people should look to state traffic officials for recourse and protection.



Transportation an Essential Part Of Any Comprehensive Planning

ROLAND B. GREELEY

Professor Greeley is Associate Professor of Regional Planning, Massachusetts Institute of Technology, and a member of Adams, Howard and Greeley, planning consultants. He was planning technician for the New England Regional Planning Commission for nine years. Then he went to Massachusetts Institute of Technology in 1945. Formerly Professor Greeley was a member of the Board of Governors, American Institute of Planners, and managing editor of the American Institute of Planners Journal.

CITY and regional planning deal with the physical environment as a whole. And of that environment, transportation is an essential component – a more dramatic component in this day than ever before.

Comprehensive *planning* of the environment therefore includes transportation as one of the major elements of the total planning process. A highway planner may consider transportation planning as related to comprehensive planning; a city or regional planner necessarily views *highway* planning as an *integral part* of comprehensive planning.

Of the deficiencies one can observe in evaluating the results of planning during the last generation, one of the greatest is the absence of integrated planning for transportation with other planning factors – at least so far as the effecting of plans is concerned. Transportation facilities, especially highways, have been planned with too little regard for comprehensive plans for the environment – usually because *no such comprehensive plans exist.*

There have been outstanding examples of thoroughly integrated highway and expressway plans, with provisions for development of land use and circulation. But at the other extreme the situation has resembled a grounds-keeper's being given a lime-marking device to mark out an athletic field without being told what kind of game the field would be used for. If one wants to play football it doesn't help to mark out a diamond with foul lines, because such were there before the rain.

A major point of relationship between highway planning and comprehensive planning to be emphasized is that lines of transportation inevitably, almost irresistibly determine the patterns of land use and activity. Decisions on highway location are in effect decisions affecting future land use, future economic activity, future residential and commuter patterns. Whoever plans the location of highways is committing, to a large extent, the comprehensive plan.

In general the transportation planners – particularly the highway planners – have done a thoroughly commendable job of anticipating the trends of growth in traffic desires, and in development of industry, business, and residence. Except where the purse-strings have been pulled too tight they have reflected trends pretty skillfully and provided the needed facilities in time.

Relationship of Highways to Land Use

One of our basic assumptions – a tacit assumption in many instances – has been that the pattern of growth indicated by past trends and present conditions will, and should, continue in a more or less straight line. The fact is, that patterns of activities and of land use will frequently change so significantly that "normal" development will be better served by radical changes in the highway pattern than by expanding the present pattern on conventional lines.

Desirable development, from the standpoint of total environment, may be encouraged by major alterations in the highway pattern whereas logical extensions to or fortification of the established pattern would foster an undesirable land use development.

Let me illustrate both aspects of this point by reference to the Massachusetts Route 128, the expressway around Boston. For years prior to its construction arguments were rife as to whether the traffic destined around the circumference would be sufficient to justify the cost of such a facility. Finally it appeared that the volume of such traffic, and the consequent relief of the burden on radial routes, would justify the cost, and the expressway was built.

The immediate result was the mushrooming of light industry and commercial establishments easily accessible to the Route via clover-leaf interchanges. It may have been a moot question whether "normal" trends really justified Route 128. But it has been dramati-

cally demonstrated that this relatively new type of facility was entirely justified by the new pattern of land use development which it made possible.

The second aspect of the problem – what is desirable – confronts us. The present tendency indicates that Route 128 may soon constitute the spine of an almost continuous ring of commercial and industrial development about a dozen miles out from the city center. Is this a pattern of development which makes sense for the metropolitan area as a whole? Even if the expressway itself could be made adequate to carry all the traffic which would thus be generated (a highly unlikely assumption), would the resultant pattern of land use and circulation actually be efficient, economically sound, and wise from the standpoint of other parts of the metropolitan area? Already, in the few years since this expressway was first opened, one new interchange has been inserted, and others are under consideration, to serve intensive new development. Again ignoring the effect upon the carrying capacity of the highway, does the emerging land use pattern along this route fit in logically with desirable land uses for the rest of metropolitan Boston?

The demand is apparently there; the highway decisions are the all-important actions affecting the result; but the basic decisions are clearly functions of a comprehensive metropolitan plan – not merely functions of traffic demand. I do not wish to suggest what may be the "right" decisions; but I do want to emphasize that whatever decisions may be made are not merely related to traffic capacity and land use along a major highway. They will have profound implications for land use throughout the metropolitan area, and perhaps for the financial stability of the city's entire core.

Relationship of Highways to Transit

A second fundamental inter-relationship exists between highways and mass transportation. Compared to mass transit, the private automobile is a less economical, highly convenient and pleasant form of transportation for the commuter. We know our major cities cannot exist in anything like their present patterns without mass transit. We know that even despite large subsidies mass transit finds it difficult to compete with the private automobile for the

suburban commuter. It also seems patently clear that any sound long-range solution of the problem will depend upon integrated planning of these two systems of public transportation rather than upon unco-ordinated competition for the taxpayer's dollar.

Certainly the solution of the commuter problem in large cities does not lie in the provision of more and more lanes of expressway for the private car: it lies in discovering that complementary system of highways and transit lines which will most effectively promote and serve a truly functional pattern of land use. Such a system cannot be pieced together by extracting some parts of a highway plan and some elements of a transit plan, and then trying to relate them to each other. Such a system will be evolved only when the highway, transit line, and land use potentials of the area are studied as components of a single functioning whole, and the roles of each component are determined by what it contributes to that whole.

The City of Newton, west of Boston, is harried by proposals of three different transportation agencies to "serve" it with improved facilities: a new rapid transit line, a toll road, and a public expressway. The question cannot wisely be decided on the basis of which is "the most economical." The problem is one of finding the best integrated solution for transit, highway traffic, and land use for the entire city and surrounding area, as a whole.

Relationship of Highways to Parking

This suggests a third significant point: the inter-relationship between highways and parking facilities. Origin and destination surveys have revealed considerable information as to the destination of vehicles in our cities: work, shopping, pleasure, etc. But in the last analysis the automobile has only one destination: a parking space, either at the curb or in an off-street facility. The traffic capacity of an artery, or a local street, may most often be determined as a function of the traffic demand. But the actual useful capacity of a system of city highways is very often determined by the capacity of parking spaces in the city.

Excess capacity of highways leading in frequently results in excess congestion of city streets where curbs are lined with parked cars. For the state, which builds the expressway, to say that the

off-street parking problem is a local concern is to duck the issue. The capacity of the radial highway system must reflect not only the apparent traffic demand but also the actual and prospective supply of parking facilities. And the supply of parking facilities must in turn be related to the comprehensive land use and circulation plan for the central area. These are not separate, or separable problems: they are part of one large problem.

A study of the traffic potential on major arteries feeding the center of most any of our larger cities will indicate that the demand will exceed present capacity by two or three times in the not-distant future. But many of these studies, if carried further, would reveal that when and if highway facilities are expanded threefold the demand for parking will be such as to squeeze out a large proportion of shopping and office buildings that now generate the traffic.

The parking problems of our major centers are not, in general, insoluble. But they will not solve themselves. The major contributions to downtown rehabilitation have been, and will continue to be, those proposals in which revitalized land use, parking, and highway access are elements of a single design.

Thus far we have been speaking in generalities. Let us look beneath these generalities to a few specific points.

Expressway Interchanges

With the large-scale construction of limited access highways the locus of high-value areas, as affected by unusually good accessibility, assumes new characteristics. Just as the railroad station, the trolley line, and the general-purpose highway have, successively, been major determinants of urban, and particularly commercial, development in the past, now the expressway interchange and the "service road" will be prime influences in the patterns now emerging.

The decision as to where to locate an interchange has implications far more significant than just the effect of the resultant traffic load on the intersecting street. It directly affects the demand for land along the intersecting street, and can mean the difference between low-density residential development and high-density urban-type development throughout a surrounding area of several square miles.

Frequent interchanges may induce what amounts to strip development along the expressway; more widely spaced interchanges may result in a nucleated or clustered type of development; spacing of interchanges at intervals of several miles in a suburban area could have the effect of withholding large areas from most any type of urban development.

Similarly, the decision as to whether the expressway should or should not be closely paralleled by a service road is one which profoundly affects the land use pattern. To proceed on the assumption that the relative costs of access condemnation and service road construction should be the deciding factor is to allow a few dollars' difference at one moment in time to determine the investment of millions over a period of several decades. No highway engineer would put a series of ten-degree curves into an expressway to avoid condemnation of a couple of houses; neither would a comprehensive planner want to allow a minor expense for access rights to determine whether an area of several hundred acres along an expressway will be devoted to low-density residence or high-intensity commercial strips.

Yet the decision for or against a service road may often have just such far-reaching implications. It must be granted that the present character of land use along the expressway right-of-way should be a major determinant. But it must also be conceded that this character, as expressed in dollars of present value, should by no means be considered as the only significant factor underlying the decision.

The pattern of land use in rural and suburban areas, within several miles of any expressway, will be determined in large measure by the location of interchanges and service roads along the expressway. In the last analysis the highway planners must be expected to make the all-important decisions as to where these locations will be. In making these decisions they are committing acts that will greatly affect future land use, economic, and social patterns of society. There are no established standards, guides, or rules of thumb on which such decisions can be based; but so far the comprehensive planning approach seems to offer the best techniques society has yet evolved for coping with such problems.

A comprehensive planning problem closely related to the one

discussed is the problem of how best to provide necessary services for the motorist on long-distance, heavily traveled expressways. Present policy insists that no service facilities of any sort shall be provided directly on units of the 90–10 interstate highway system – not even the gasoline and restaurant concessions so familiar on existing expressways and toll roads. Such a policy has many implications. One direct result will be the springing up of highway-oriented services on most feeder roads close to the expressway clover-leafs.

Expressway Service Areas

Where there is a "visual access" to these service areas from the expressway, or where advertising matter can be so placed as to be visible from the expressway, the service areas will be most successful. But in the future the expressway traveler will probably have good reason to expect that wherever he turns off an interstate highway onto an ordinary highway he will soon find the gasoline, eating and sleeping accommodations he requires.

At least three implications of this policy I would like to examine: traffic, service to the traveler, and land use planning.

From the traffic point of view it may be argued that the best expressway has the fewest turn-offs, and that therefore turn-offs should be limited to only the essential clover-leaf intersections. On the other hand, I believe it is fair to say that we do know how to design turn-offs at expressway service areas, especially where we can pick favorable topography and sight-lanes, so that they are relatively safe. We ought to be able to handle an occasional turn-off, especially in rural areas where clover-leaf intersections are infrequent, so as not to increase significantly the hazards to high-speed traffic.

But this is only half of the picture, insofar as traffic is concerned. If the traveler is forced to leave the expressway at a clover-leaf to find the necessary services, then these services are going to be located at one of the most congested and hazardous spots in our total system – the spot where high-speed expressway traffic is suddenly dumped onto ordinary highways, or where local traffic is gathering to spew forth onto the expressway.

And into these spots we propose to force the expressway traveler

who neither needs nor wants to be there, actually; and in so doing we are going to force him to make at least one left-hand or cross-lane turning movement on a busy local highway (either entering or leaving the service facility). Traffic-wise the policy may slightly reduce the accident rate on the expressway; but I doubt if it will reduce the over-all accident rate.

There can be no doubt that the motorist would prefer to find service facilities along the expressway rather than be forced to leave the expressway to search for such facilities. It may be argued that he would prefer a variety of facilities, such as he might find on the feeder road, to a single concession with a privileged monopoly location on the expressway.

The counter-argument to that is that it would be quite feasible, where the expressway will in fact carry a high volume of traffic, to have a well-designed stretch of service road along the expressway with only one or two well-engineered turn-offs and entrances. The motorist could drive along such a service road, without breaking his direction of travel, and choose among a potentially large assortment of service enterprises. Obviously such service strips would have to be infrequent, and would support a large number of enterprises only where traffic was relatively heavy. But there would be ample demand to support scores of such service strips along the interstate system in the northeast and in most recreation areas.

This brings us to the third question: what are the implications of such a policy from the standpoint of land use? If service areas are forced off of the interstate system, then the only reasonable location for them is on feeder roads close to the expressways. Specific locations can be adjusted somewhat in deference to established and desirable patterns, but there is no real choice. Sooner or later the demand would be felt so strongly, in the typical situation, that local controls would be futile.

Whether it made sense from the standpoint of local utilities, local business centers, or surrounding residential land uses, highway-oriented commercial facilities would tend to become the rule along these feeder roads. In the vast majority of cases the main approach from the interstate highway system to city, village, or resort area would be through an aisle of gas stations, restaurants,

and motels. Some, perhaps many, might be reasonably well-designed; but is this a land-use pattern we would deliberately choose?

One more comment: I advocate judicious use of service roads, with decisions as to location based at least as much on comprehensive planning of land use and circulation and local economics, as on highway finances, traffic efficiency, and administrative simplicity.

Highway Research

There is one more complex and highly important respect in which transportation factors are closely inter-related with comprehensive planning – and that is the matter of basic planning research. We have made tremendous advances in highway engineering; we have made some significant progress in the art and science of comprehensive planning. But in many respects our practice is moving forward at a much more rapid pace than our knowledge. In short, there are many problems which directly affect transportation and land use planning where there is significant need for research.

Knowledge of how to relate activities to traffic flow is very meager. We may obtain highly detailed information on the differential distribution of daytime and nighttime population, and on the patterns of residential and non-residential land use, but still we find only very crude indices, at best, of the volumes of traffic which are generated by the daily movements of people. Some pioneering work has been done, in Detroit and elsewhere, but not nearly enough to create understanding of the phenomena, or much less, to permit reasonable prediction of what will happen a few years hence.

Can we assume that the flow of traffic in and out of residential areas is correlated, in some way, with the size and characteristics of those areas? If so, what are the variables, and in what ways do they affect the flow? In what way have the variables changed over a period of time, and accordingly what is likely to be their direction of change in the near future? These questions, and similar ones related to other types of land use, have not been answered adequately to date.

There must be answers if we are to plan intelligently. Here is a common field for research by both highway and city planners, the results of which would be of inestimable value for both. We spend

huge sums of money in making origin and destination surveys. Can't we learn significantly more from such surveys, collectively, than just the pattern of desire-lines in the specific areas surveyed?

Shopping patterns seem to be undergoing revolutionary change. The regional center, the large-scale enterprise surrounded by acres of parking space, is hailed far and wide as *the* shopping area of the future. But is this actually so? Do we know to what extent shopping is automobile oriented? Do we know what proportion of shopping occurs in multi-purpose, as contrasted to single-store trips? Do we know how much shopping is linked to place of work, to commuting trip, or to home?

This again is a problem of grave concern to all categories of planners, but one about which there is a paucity of reliable data. Perhaps the situation is changing so rapidly that it is impossible to forecast at all accurately what will happen only a few years hence. Nevertheless the changes will affect the validity of the decisions we make today; and the decisions we make today will affect the rate of change in shopping habits. This then is, I suggest, another field where highway and city planners sorely need more knowledge, more research.

The planners have, for years, considered the highway, or busy street, as an intrusion in a residential area. The "best plans" have succeeded in keeping traffic entirely out of the residential neighborhood. If possible, it has been asserted, no elementary school child should have to cross other than a "purely local" street. To what extent are these valid objectives? Are the planners justified in trying to separate residence from traffic? If the highway planners have asked these questions seriously, and answered them in terms of fundamental principles, I am unaware of it. But it seems to me that answers to such questions, in reasonably concrete terms, are desirable. We have finally arrived at pretty general agreement that house-lots cannot be allowed to front on expressways – for the sake of the expressway.

But is it conceivable that there are categories of highways, other than expressways, on which it would be undesirable to have house-lots – for the sake of the home-owner? Admittedly this type of question is probably not susceptible to any precise determinations; nevertheless some intensive study of this highly important, ever-

present problem may be well worth more attention than we have yet given it. If the highway and city planners could agree on some of the basic issues, rather than frequently appear to be on opposite sides of a controversy, both would be performing a greater public service.

Related to this problem of highways in residential areas is that of school access. It is now becoming common practice for communities to provide school bus transportation for pupils who live very short distances from school, because of the danger of the walk to school. Is this a reasonable, logical solution to a problem? Or does the provision of adequate sidewalks offer a more rational solution in those areas where the route between home and school carries heavy traffic?

So far as I know this is not a problem which is usually accepted as being within the province of the highway planner. Is it not, nevertheless, one where the highway planner can be expected to provide basic information and policy guidance? Despite the leadership taken by the highway planners in most matters related to the movement of vehicles, initiative relative to sidewalk policy, and improvements, has frequently been relegated to the city planner, or the politician. As a city planner I would enter a plea for assistance from the highway planner not only for funds but for knowledge, experience and research into the general matter of sidewalk policy in suburban and rural areas.

There are many other fields for both fundamental and operational research where the resultant gains in knowledge about the functioning of our total environment should be of inestimable value to all categories of planners. For example:

What is the part to be played by heavy trucks in our future transportation system? What are the facts relative to the demand for highway-oriented picnic areas, camping areas, and trailer parks? What now seems to be the ultimate function of the limited access highway, as contrasted to the conventional highway? Can we see, over the horizon, some compromise between the bona fide expressway and the conventional rural highway, for use in rural and recreation areas where heavy volumes of through-traffic are not anticipated?

If we are, in fact, going to be able to relate transportation

planning to other components of comprehensive planning for the environment, then there are two major approaches which must be followed. First, the highway planners and the comprehensive planners must join forces in carrying on research which will answer some of the many fundamental questions that confront us both. Second, the highway planners and the city and regional planners must work together in the early stages of highway layouts and comprehensive planning programs, to the end that determination of the total land use and circulation pattern will result, for all practical purposes, from a single co-operative planning process.

California's Land Economic Studies Along Controlled-Access Highways

FRANK C. BALFOUR

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EVERY man, woman and child in the United States will feel the tremendous impact of what might appropriately be called the "Highway Revolution." All effects of the present expanded, controlled-access highway program will quickly work their way through the community's economic fabric. The impact can be expected to be astonishing.

Evidence of the effect-producing nature of the controlled access highway shows that governmental jurisdictions, home owners, businessmen and industrialists and persons in government are already asking, What is the economic impact of the freeway and expressway upon my community, my home, and my business?

Where Are the Answers?

Few sources of sound, factual information are available to vitally interested persons. Many may see the cement and asphalt harden on many miles of controlled access highways before answers are forthcoming.

This paucity of timely, understandable material became the concern of the California Division of Highways, with the result that the land economics studies section of its right of way department was brought into being. Research has whittled away at economic problems; sound, factually based answers have evolved.

What has been California's experience with the impact of controlled access facilities upon our urban areas? Economic effects of the freeway and expressway in California's experience, based solidly on factual research, puts the case strongly for the freeway facility as an economic force for community betterment.

The term "thus far" has been used because the total story is yet to come – this type of economic analysis is a continuing one. It deals with the dynamic interplay of community economic forces in constant flux. Further, it is primarily in the final, over-all picture that the fullest meaning will be found. Studies into the effects of new highway design upon numerous community facets remain to be completed and analyzed. Each new phase lends something to the whole that will finally round out the picture.

California has separated and examined the major component community economic parts. Collectively they have been considered fairly indicative of the effects upon the urban whole.

Something New?

The expanded national highway program, which has made the nation freeway-conscious, has not created new informational needs and problems. These were facing community planners and right-of-way agents almost as soon as the first mile of controlled access highway was designed years ago. However, the tremendous roadway system taking shape did bring the necessity for critical economic analysis of controlled access effects into sharper focus.

Many jurisdictions are just becoming familiar with the controlled access concept; many have thus had little chance to observe, first-hand, the impact of this facility, with its resultant dynamic effects upon their community. And it is only in careful, constant observation that sound, worthwhile answers will be found. Perhaps California's experience may materially lessen the time required for others to develop answers to the questions that an alert citizenry in increasing numbers rightly demand.

The Why of Land Economic Research

Highway land economic studies are not theoretical, academic researches, but vital and necessary media for carrying out a con-

tinually improving job – the job of approaching, as close as humanly possible, the disbursement in right-of-way acquisition of a truly "just compensation." That the research and information disseminating activities of our Land Economics Studies Section are continuing to contribute to the attainment of that high goal is unquestionable.

Economic studies have made as equally valuable a contribution to the progress of California's highway improvement program through timely assistance in increasing the degree of public acceptance and understanding of the controlled access principle.

Savings in time alone brought about by this increased public acceptance (again, an awareness advanced substantially by a planned program of sound economic study and reporting) has undoubtedly brought untold miles of freeways and expressways to the "completed" stage many years sooner than otherwise would have been possible. Only completed, controlled access highways can effect the savings in lives, time, and money that make the freeway design superior to any highway type heretofore developed.

Important Right of Way Function

It is obvious that successful acquisition of right of way must be predicated on a completely integrated appraisal and negotiation process: The appraisal must result in an equitable settlement, negotiations grounded upon sound data. Every professionally achieved appraisal requires careful consideration of comparable properties, of neighborhood sales data and trends, of area functions and community relationships.

It can readily be seen that research into land economics is an extension and projection of the appraisal process. Facts developed are vital to successful negotiations and to the establishment of a sound public relations program on the part of the right of way department.

The highly trained right-of-way man knew the problems his profession faced. He had long dealt with groups and communities asking, in the early freeway days, apparently unanswerable questions. He was also, more than anyone else, fully aware of the vital necessity for a sound and accurate "down to earth" approach that could stand the give and take of day-to-day negotiations with

property owners who wanted no part of abstract or theoretical research.

Perhaps it was inevitable that the Right of Way Agent should develop the economic impact studies that have provided, and are continuing to provide, the much-needed answers to the ever growing number of freeway impact questions and problems.

Methodology

In California we have researched the economic effect of freeways and expressways upon commercial, industrial, residential, and agricultural properties. We have examined single businesses as well as vast, almost regional, industrial developments. Small unincorporated towns and sprawling metropolitan areas have been under continuous scrutiny.

Although several techniques may be employed according to the requirements of the specific situation, the soundest results have been obtained through the use of sales tax returns and land sales and resales. These criteria have successfully supported a continuous testing program extending over ten years. (Fig. 1.) Their application to actual case study areas of varying size and economic complexity throughout the state has yielded a valuable fund of factual data from which certain basic observations have been carefully drawn.

From these data it has been possible to summarize the observed economic effect of controlled access facilities upon the urban complex, and there follows a general discussion of some of the more important observations.

Effects Upon Residential Properties

Nowhere is the lack of factual data as alarmingly apparent as it is in this phase of land economic study. Yet, the home owner may be said to have a greater stake in an expanding, controlled-access highway program than any other segment of the community. The importance of stability of value to the residential property owner is proportionately greater, perhaps, than to that of any other investor; certainly, at least, his concern with the small piece of real

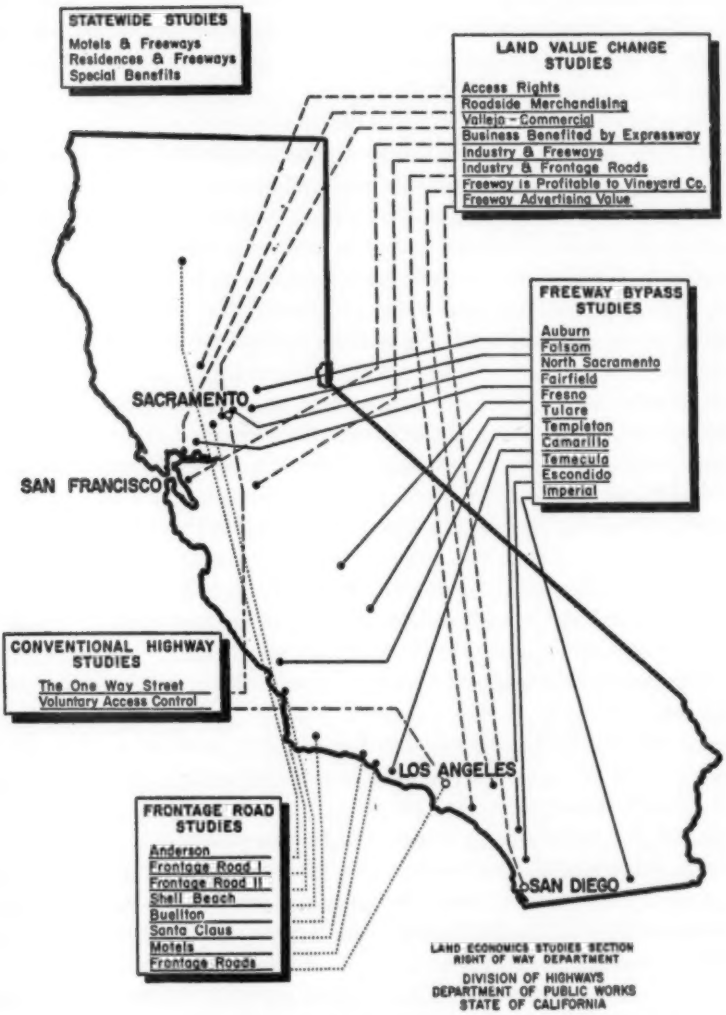

STATEWIDE STUDIES
Motels & Freeways
Residences & Freeways
Special Benefits
LAND VALUE CHANGE STUDIES
Access Rights
Roadside Merchandising
Vallejo - Commercial
Business Benefited by Expressway
Industry & Freeways
Industry & Frontage Roads
Freeway is Profitable to Vineyard Co.
Freeway Advertising Value
FREEWAY BYPASS STUDIES
Auburn
Folsom
North Sacramento
Fairfield
Fresno
Tulare
Templeton
Camarillo
Temecula
Escondido
Imperial
SACRAMENTO
SAN FRANCISCO
CONVENTIONAL HIGHWAY STUDIES
The One Way Street
Voluntary Access Control
LOS ANGELES
FRONTAGE ROAD STUDIES
Anderson
Frontage Road I
Frontage Road II
Shell Beach
Buellton
Santa Claus
Motels
Frontage Roads
SAN DIEGO
LAND ECONOMICS STUDIES SECTION
RIGHT OF WAY DEPARTMENT
DIVISION OF HIGHWAYS
DEPARTMENT OF PUBLIC WORKS
STATE OF CALIFORNIA

Figure 1.

estate that comprises his and his family's home is most intense and vital.

To shed light upon this important question, our land economic studies section recently completed an exhaustive study, Residences and Freeways. It constituted the initial full-scale research into the problems arising out of limited access development across residential subdivision properties in California.

This factual study is the first research of its kind undertaken by a public land acquisition agency anywhere in the world. The need for such a sound analysis has long been pressing and the right of way agent in the field has long been impatient for the conclusive type of factual information that only such a broad study could achieve.

But if its validity was to be maximum, its coverage had to be maximum as well, and thus a truly comprehensive research was delayed until a sufficiently significant number of case studies were available. The residential tracts included in this statewide study comprised a total of 22,396 homes with 1,697, or 7.58 percent, built alongside a freeway. In measuring the trends in prices of freeway-adjacent parcels as compared to similar parcels one block or more away from the freeway, 1,092 resales were investigated and analyzed.

Results from such a painstaking analysis, indeed reliable, indicated that buyers and sellers, participating freely and with full knowledge of the real estate market in their locality, have expressed through actual transactions, acceptance of a freeway alongside their homes with only a slight (one to two percent) depreciation in marketability. This difference of one to two percent in the resale price in homes adjoining freeways, as compared to similar homes one block or more away, can actually be attributed to the widespread doubts resulting from opinions that freeways exert an adverse effect upon the market value of residential property. These opinions are, unfortunately, influential during the bargaining procedure engaged in by buyers and sellers at the time of resale negotiations.

In focusing attention upon the 7.58 percent residence-segment, i.e., the homesites adjacent to the freeway facility, the remaining 20,699 residential parcels are apt to be entirely forgotten.

That the freeway, through its reduction in travel time alone, has con-

tributed to the wealth and well being of the entire community by bringing such areas into valuable development in an appreciably shorter period of time than would have otherwise prevailed, is certainly an effect of no small significance, and one which should as certainly not be overlooked.

Land Use Changes: Case Studies

One of the most profound effects wielded by the controlled access facility upon abutting and adjacent lands can be found in its striking stimulus to the immediate use of available property.

This acceleration can bring an earlier development of the existing use, or it can induce a higher, more profitable use of abutting lands. Case studies in industrial areas are numerous and instructive.

Careful research along the Santa Ana Freeway in the Los Angeles area developed specific case material from a significant number of new manufacturing and industrial firms located adjacent to the new freeway facility. *The large majority of industries studied selected their plant sites in anticipation of the highway improvement.* The stimulus leading to desirable growth and enhanced values resulting from such a "typical" freeway will be more fully described in the following discussion on land value increases.

Looking farther north to Alameda County in the San Francisco Bay Metropolitan Area, to the properties adjacent to the Eastshore Freeway, we find perhaps the classic example. 43.1 percent of the total expenditures for new industrial development in Alameda County have taken place in the freeway-influenced area. The significance which can be attached to this comparison becomes apparent when it is further stated that the area of influence studied represented only nine percent of the total industrial acreage in Alameda County. The remaining ninety-one percent of industrial land in the county accounted, then, for only 56.9 percent of the expenditures for new industrial development.

Industrial preference for the vacant freeway location arises primarily out of anticipated benefits of improved transportation upon the costs of production and distribution. Greater accessibility to labor and markets resulting to industry from the freeway location have contributed substantially to the acceleration of this type of economic development. It follows that an already established

industrial enterprise that finds itself either adjacent or in close proximity to such a facility has realized a valuable windfall.

Land Value Effects: Case Studies

Benefits inevitably following construction of controlled access facilities throughout California can be expected to find reflection in several segments of the community's economic structure, analysis has clearly indicated. Land value increases have been apparent in a significant number of study areas to justify the generalization that controlled access highway development exerts a highly beneficial effect upon abutting and adjacent lands.

A portion of the Eastshore Freeway, in the important San Francisco Metropolitan Area, was subjected to an intensive analysis to determine, among other things, the effects of freeway construction on the value of adjacent lands and upon the land uses. All sales since 1941 of parcels of land within the freeway zone of influence were available for making the study.

When right of way acquisition began on the "freeway study section," the property sales indicated an average price of $500.00 an acre. At the time of construction, with the controlled access highway in sight, acreage was selling at the rate of $2,000.00. After construction and opening of the freeway to traffic, lands within the zone of influence were selling at a stabilized $10,500.00 per acre, leveling off from a peak acreage average shortly before of $11,300.00.

Recent industrial subdivision within the area has boosted values even higher; average selling prices for the new industrial lots (as early as 1954) were from $21,000 to $26,000 an acre.

On a nine-and-one-half-mile stretch of expressway adjacent to the south city limits of Fresno, California, property values were analyzed in over forty sales of lands abutting upon and immediately adjacent to the controlled access facility. In not one instance did the properties studied sell for a lesser sum an acre than the indicated value prior to freeway construction. The increase in prices per acre over former levels ran as high as $4,700 – the over-all average increase amounting to 200 percent.

Farther south, controlled access studies along the Santa Ana Freeway in Los Angeles showed major gains in property values

attributable to the highway improvement. Comparison of value increases between affected and unaffected locations at one stretch of the freeway showed a 243 percent increase affecting properties abutting the controlled access facilities. Prices an acre ran, over the years, from $7,800 to $25,000 and one sale pointed to new highs when it brought $55,000 for a one-acre industrial site.

In the freeway-bypassed North Sacramento area in Northern California, the highest priced sale in the downtown business district prior to the completion of the bypass was at the rate of $220 a front foot. After the freeway opened, the highest price paid for downtown business property was $320 a front foot. The average of all vacant property sales over a similar period went from $160 to $290 a front foot, clear evidence of higher land values brought about by an increase in business activity and potential.

As a further measure of controlled access effects upon the community property valuation base, a compilation of county taxes levied in the town of Camarillo, California, was achieved, and its results offer striking evidence of the increased land and building valuations obtaining in that area after freeway construction. Eliminating districts in the community which were not directly affected by the freeway development, the record shows a 61.86 percent increase in county taxes levied over the four-year comparison period.

Community Bypass Effects

Removal of through traffic from heavily traveled business streets within the urban area's communities has resulted in substantial business gains. These gains have exceeded those of comparable commercial areas situated along conventional streets and highways where no change in the traffic pattern has taken place. California studies offer numerous examples.

In one of its earliest researches, the Land Economics Studies Section reported on the effects of a controlled access bypass upon the city of North Sacramento.

Investigation revealed that although average daily traffic through the city dropped forty-four percent after the North Sacramento Freeway opened, the total volume of business in the district rose thirty-one percent during the ensuing two-year period.

All classes of retail business abutting the bypassed highway were benefited. In every case, their gross sales exceeded the average throughout the county in the two-year period following the freeway opening. The increase in gross volume of business was so much greater than the county rate of increase that the volume of all business per establishment in North Sacramento showed a gain of twenty-eight percent as compared to less than a ten percent increase in the county during the same period.

North Sacramento is a highly developed suburban city within the metropolitan area of California's capital city, Sacramento. That the beneficial effects of freeway construction are confined to such an urban complex is a conclusion which must not be drawn, and further studies emphasize the fact that beneficial effects are similarly experienced in smaller, agriculturally-centered communities.

Anderson, California, Shasta County (Fig. 2) is the antithesis of North Sacramento in community pattern and economy. Here is the unincorporated, agricultural community whose chief livelihood is derived from dairy farming and the lumber industry. A four-lane divided expressway was constructed through the town's business district in mid-1950. In the next two-year period, Anderson's gross sales were higher than those in Shasta County for all types of retail outlets. Percentagewise, total business in Anderson was forty-nine percent better during the two years after the opening of the new expressway as compared with the two years before. During this same period, all retail business in Shasta County made only a twenty-seven percent gain.

In addition to the countryside comparisons, it was possible in this study to make comparisons between the two retail areas within Anderson itself, one unaffected by the highway change and thus an ideal "control" area. Investigation disclosed a gain in gross volume of retail business for the area of highway change of sixty-one percent while gross volumes in the area which had undergone no change were advancing only thirty-seven percent.

Immediacy of Effects

There is little evidence to indicate that the benefits of controlled access development are necessarily slow in coming. On the con-

trary, stimulating effects may be felt much sooner than might appear to be the case from the four-year comparisons noted before. The town of Camarillo, located fifty miles northwest of Los Angeles on U.S. Highway 101, was carefully studied in late 1955, one year after through-traffic diversion to a freeway facility had taken place.

The re-routing of the highway entirely changed the traffic pattern to which this community had become accustomed, and yet, within one year, the merchants were already showing a greater retail business increase than was being recorded in the control county (Camarillo is located in Ventura County) over a similar period of time.

Long-Term Study

There is valid evidence of the long-term impact of the controlled access highway as well. In studies over a short period, extreme care must be used so that minor deviations are not taken for longer-term, more stable reactions. One of the best means of objectively recognizing the characteristics of both long and short term adjustments and reactions is to subject the same area to continual scrutiny over a relatively extended period of time. This is exactly what was done some four years ago in the California community of Fairfield.

Freeway bypass construction was completed in this city in 1949, and an initial study was made in 1951. In 1953, four years after through-traffic diversion had been completed, a second study was carefully made of the same community. In the first analysis, a direct comparison of the conditions before freeway construction with the conditions immediately following was achieved; therein lay the story of this city's reaction to the new highway development.

The later Continuing Study, while measuring the trend in business over the entire four-year period, developed into a factual portrayal of the local businessman as he progressed through the adjustment period. His ability to merchandise to the changing community and move with it into an era of stabilized "good business" became readily apparent. The longer-term effects of controlled access development became clearly evident.

Businesses that responded quickly to the construction of the new facility – which had felt the uplift of freedom from congestion

almost immediately – were continuing to grow and prosper. Those traveler-catering merchants, likely to be most through-traffic sensitive, who had suffered earlier setbacks, had made a more than satisfactory adjustment.

These latter merchants were, in the four-year "after" period, enjoying higher business returns from the increased patronage of local customers, now more free to do business without the conflict from through traffic. It was apparent that the lasting effect upon Fairfield of the access controlled bypass was one of substantial benefit.

Business Trends Along "Superseded Highway"

That controlled access development can have a beneficial effect upon new business growth along the old highway in the bypassed urban community can likewise be shown. In the Camarillo area, 22 of 29 new commercial structures were built along the "superseded" highway during the period when traffic diversion to the controlled access facility was accomplished. Restricting the comparison somewhat, we find ten new businesses started in the town in the "after" period, choosing locations along the old highway route. In bypassed North Sacramento, the "after" period saw a sixteen percent gain in number of businesses in operation while the same period saw a less than six percent retail business increase in the county as a whole.

Recent studies in West Sacramento (Fig. 3) offer even more striking evidence of investor preference for "bypassed" locations. Fifteen new motels, representing an investment in the vicinity of $3,000,000, have been constructed along the "superseded" highway since ground was first broken for the controlled access bypass completed in mid-1954.

This substantial expansion in motel units increased the available rooms in the area fifty percent and brought the total number of available units to more than 1100. This "bypassed" business street was clearly maintaining its desirability for investment and had suffered no ill effects from through traffic removal.

California's experience with the controlled-access highway facility has been pleasant and satisfying. This statement, based on years

Figure 2. Aerial photograph of Anderson, California, representative of a typical expressway – frontage road study situation in a small lumber and agricultural area.

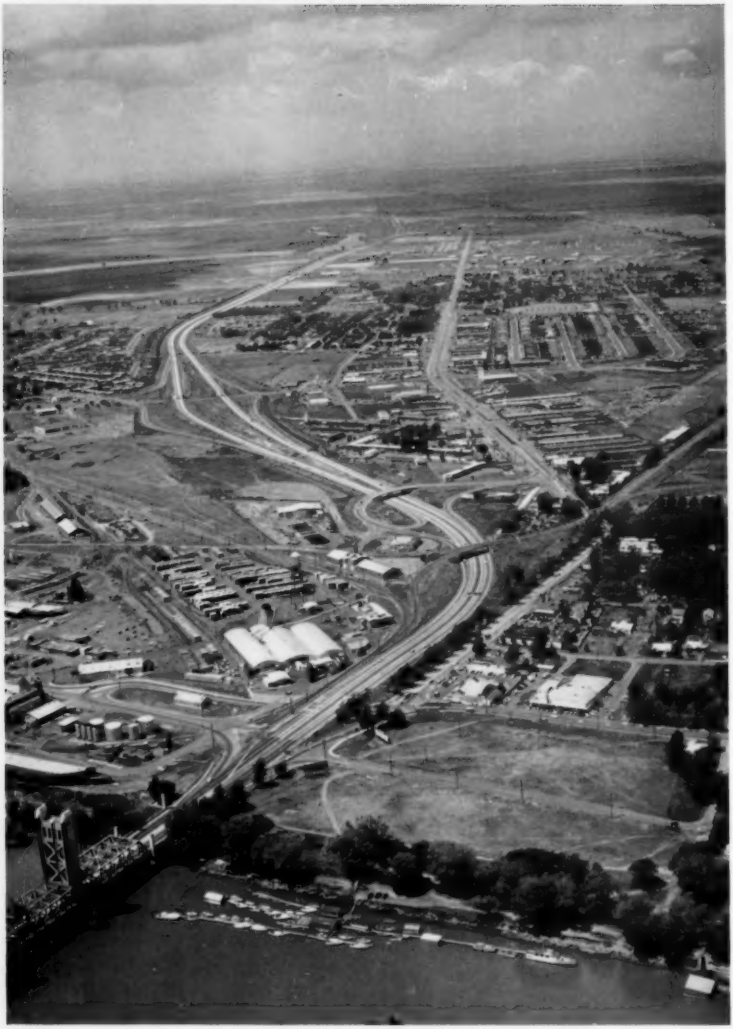


Figure 3. Aerial photograph of West Sacramento, California, typical of a freeway bypass study area involving the larger community adjacent to a growing metropolitan city.

of research and study, comes from close scrutiny of every part of the community fabric through which the economic effects of the controlled-access facility have been distributed.

The extreme importance of a well planned land economics study program that can yield the meaningful facts so necessary to a successful highway program, cannot be overemphasized. Its many dividends have already been described.

But there is another dividend, and it represents the most satisfying and perhaps least discernible contribution that land economic study and reporting have made to California's highway progress. I refer to literally thousands of Californians, the owners of the thousands of right-of-way parcels acquired for freeway location and construction. These property owners have become controlled-access supporters. This is a meaningful tribute to the successful dissemination of the freeway story by the 433 agents in our Right-of-Way Department.

The soundly derived economic data continuously developed by the Land Economics Studies Section have given real significance to the varied facets of co-operative community-state planning activities; have facilitated right of way appraising, negotiating and public relations programs; have contributed to the successful undertaking of the vast controlled-access highway development program which is so vital to the welfare of our state and nation.

Causes of Highway Accidents: United States Experience

LIBERT EHRMAN

Libert Ehrman is Vice President of Stuart Rice Associates, Incorporated, in Washington, D.C. The firm performs research and consulting work as advisors to governments and industry on a wide range of economic, statistical, marketing and management problems. Mr. Ehrman, a social scientist, has extensive experience in the field of safety. During World War II, he pioneered new safety research techniques at the Air Force Office of Flying Safety, a function he later carried on as Chief of Safety Analysis in the Civil Aeronautics Administration. More recently, he and Dr. Stuart A. Rice, formerly Assistant Director of the Bureau of the Budget for Statistical Standards, established the firm with which he is now associated. Mr. Ehrman is a member of the American Statistical Association, the World Association for Public Opinion Research and the Institute for the Management Sciences.

AUTOMOBILE accident research has increased remarkably in recent years. Yet few research workers in the physical and social sciences, in engineering, in medicine and in statistics are satisfied with the adequacy of presently available accident cause information upon which prevention is based.

They are continually reminded of the need for improved cause data by the mounting toll in lives, in human misery and in economic loss resulting from highway accidents. It is true that they are able to take some satisfaction from the steady decline in accident rates in the United States. But the equally steady increase in the number of vehicles and in the number of miles traveled has increased the exposure of the population to accidents. As a result, the absolute number of accidents and fatalities has continued to rise. The estimated number of fatalities in 1956 in the United States

EDITOR'S NOTE: Originally presented before the Thirtieth Biennial Session, International Statistical Institute, Stockholm, August 1957. Printed with permission of the International Statistical Institute.

alone was 40,000. It is a frequently repeated truism that the nation has lost twice as many lives on the highways as it has lost in all the wars in its history.

Accident statistics concerning other nations are not widely published in the United States because of differences among them arising from lack of standardization in definitions. However, the accident situation in certain other countries appears to be as alarming as it is here. For example, a newspaper report received in the United States indicated that there had been about 12,000 vehicular fatalities in West Germany in 1956. West German automobile registration stands at about 5.2 million, whereas registration in the United States is in excess of 62.5 million. If the West German accident rate were projected on the basis of registration for the United States, 130,000 persons would have been killed here last year.[1]

Research and accident prevention efforts in the United States to reduce the accident toll have taken many forms. These include highway and vehicular design, driver education in the schools, statistical studies of accident rates on different types of highways, publicity and development of community organizations to gain public support of safety efforts, enforcement of safety regulations, driver tests, psychological studies, and many others. The status of a number of these efforts and comments about a limited number remaining to be undertaken will be noted in the following sections.

Magnitude of the Problem

Before delving into accident cause information, it is necessary to examine the statistical base, the magnitude of the problem, the extent of reporting and the economic cost of accidents, upon which such data rest. Various methods have been used to evaluate the magnitude of the highway accident problem. These include such general classifications as dollar costs, extent of damage and extent of injury.

The National Safety Council makes annual estimates of the cost of accidents in the United States. For 1955, for example, they placed the figure at $4.5 billion which included estimates broken down as follows:

1. *The New York Times*, January 13, 1957.

Table 1

COST OF MOTOR-VEHICLE ACCIDENTS 1955

Property damage in motor-vehicle accidents	$1,700,000,000
Overhead cost of insurance	1,350,000,000
Wage loss	1,350,000,000
Medical expense	120,000,000
Total (rounded)	$4,500,000,000

But the full toll of accidents cannot be appreciated in money terms alone; the frequency of accidents is equally astonishing. The total number of accidents in 1955 was in the order of ten million, a figure that includes accidents of all degrees of severity. On the basis of population this indicates that one accident occurred for every seventeen men, women and children in the United States in that year. In all, about 1.4 million persons were either killed or injured, as illustrated by Table 2.

Table 2

MOTOR-VEHICLE ACCIDENT TOTALS, 1955

Severity of accidents[a]	*Accidents*	*Injuries*
Fatal	33,100	38,300
Nonfatal injury	880,000	1,350,000
Property damage only		
$25 or more	3,600,000	—
under $25	5,400,000	—
Total (rounded)	9,900,000	1,400,000

SOURCE: Reports of state traffic authorities with estimated correction for incomplete reporting.

[a]A fatal accident is one in which one or more than one person is killed. A nonfatal injury accident is one in which at least one person was injured, but not fatally. Property damage accidents cause no personal injuries.

It is of more than casual interest that, as noted in the footnote of Table 2, these accident totals contain many elements of estimation. As a matter of fact, an accurate understanding of the magnitude of the accident problem has not yet become possible, because so many vehicular accidents, including even fatal accidents, are not reported to traffic authorities. Many reasons have been cited for this situation. Among them are these facts: Accident reporting is a matter of local or state jurisdiction and not centralized for the nation as a whole; not all persons are aware of their accident-reporting responsibilities; criteria for reporting differ from area to

area; many accidents occur in places remote from offices of central reporting authorities; drivers fear they may be subject to penalties, such as revocation of driver's licenses, if they report accidents which are traceable to their own negligence.

There has been a recognition of this problem for some time. For example, the Highway Safety Conference organized by the President of the United States estimated the completeness of accident reporting state by state in its report of 1946. Only six of the forty-eight states were believed to have obtained reports of ninety percent or more of the actual total number of accidents within their borders. Twenty-nine states were tallied as having reported fifty percent or less; of these, six fell into percentage ranges under ten percent.

The Massachusetts Safety Council and the Boston Traffic Commission had under way, at the time of this writing, a special survey of accidents in Boston aimed in part at obtaining a better summation of accident occurrences. Present inadequacies in data provided the incentive for their study:

> Accident records in the United States are, in general, very poor. Even the reporting of fatal accidents to the National Safety Council is considered to be far from accurate, and fatal accidents represent probably less than one percent of the accident picture. Reliable information on personal-injury (nonfatal) accidents is available in only a few states and probably no state has accurate information on property-damage accidents.[2]

Accident records in the Boston Police Department were known to the survey administrators also to be incomplete. The means for checking the accuracy of these data provide an illustration of one method through which accident records might be made more nearly complete nationwide.

The state of Massachusetts has had a compulsory automobile insurance law for more than twenty-five years. "When a person reports an accident to his insurance company, the insurance representative gives him a form to fill out for the (Massachusetts) Registry."[3] Information forwarded on these forms is handled according to a coding system integrated with IBM punch cards at the Registry.

2. Boston Traffic Accident Survey, Letter to the author from Commissioner William A. Railly, February 5, 1957.

3. *Ibid.*

The financial incentive in making insurance claims results in a high rate of reporting. In fact, reports for Boston received by the Massachusetts Registry of Motor Vehicles are five times greater than those received by the Boston Police Department.

The above survey method offers one of a number of possibilities for improving accident data: namely, to use information from insurance claims to supplement reports received through police channels. Other suggestions have been made from time to time in the past. One of these is to get co-operation from all insurance companies – even where there is no compulsory automobile insurance law and no central registry as there is in Massachusetts. Insurance companies are concerned with accident reduction as a matter of good business practice and are therefore motivated to participate in accident prevention efforts, many of which must inevitably be based on accident records. Other methods of checking on the completeness of accident records that have been followed with some success are: to obtain notice from mechanics, garages or repair stations of every repair made to a vehicle as a result of an accident; to follow newspaper items carefully. Both of these sources give enough information so that a follow-up can be made with car owners to get reports if none have been previously submitted.

In a large number of states accident reporting is encouraged through the medium of making them confidential. So labeled, they cannot be used as evidence in any civil or criminal trial arising out of the accident. This fact of confidentiality and an understanding by the public of the importance of accident reporting as a basis for accident prevention are not widely known. If they were, better co-operation might be obtained in accident reporting.

From the above discussion, it is clear that although vehicular accidents are known to be an important social problem, the exact magnitude of the problem has yet to be determined.

Accident Facts[4]

Although the causes of vehicle accidents are not yet as well known as research workers would like to have them, a large number of facts about the circumstances of these occurrences have been studied and compiled. This is particularly the case for fatal accidents.

4. Source of most of these data: National Safety Council.

There is a striking difference, on the basis of absolute numbers, between the frequency of fatal accidents in urban areas and in rural areas. From data available for the year 1955, one finds that three times as many fatalities occur in accidents in rural areas as compared with urban areas (cities, towns, villages), 28,900 compared with 9400. In only two of the accident categories, pedestrian accidents and collisions with bicycles, did more fatalities occur in urban accidents. All other categories of rural fatalities ranged from twice to ten times the urban total. Table 3 illustrates these differences:

Table 3

MOTOR-VEHICLE ACCIDENTS AND NUMBER OF FATALITIES

	Urban	*Rural*	*Total*
Noncollision in roadway, overturning, running off roadway	1,200	12,300	13,500
Collisions between motor vehicles	1,700	11,300	13,000
Pedestrian accidents	5,200	3,000	8,200
Collisions with fixed objects	500	1,100	1,600
Collisions with trains	500	900	1,400
Collisions with bicycles	280	200	480
Other collisions	20	100	120

The National Safety Council has described the types and circumstances of fatal accidents as follows:

Accidents in *urban* areas: Half of the accidents in urban areas involved pedestrians, with accidents between intersections nearly as frequent as accidents at intersections. Collision between motor vehicles was next in frequency, totalling over one-fourth of all urban fatal accidents. In this group, angle accidents were nearly three-fifths of the total while head-on or sideswipe accidents were a little over one-fifth. About one fatal accident in seven in urban areas was a noncollision accident.

Accidents in *rural* areas: Four out of ten fatal accidents in rural areas were noncollision accidents, and in more than four-fifths of these, cars ran off the road – some on curves, some on straight roads. Collision between motor vehicles was next in frequency, totalling nearly as many as the noncollision accidents; head-on or sideswipe accidents totalled half of these. One fatal accident in nine in rural areas involved a pedestrian.

A number of other circumstances contributing to fatal motor-vehicle accidents are worthy of note: About three out of ten drivers were violating a speed law, according to reports from twenty-one states. Roughly half of these were exceeding stated speed limits and

the other half were exceeding safe speed limits, although traveling at less than the stated speed limits or on roads where no stated limits existed. The weather was rainy, snowy or foggy in one out of seven fatal accidents in 1955, according to reports from thirty states. In the remaining fatal accidents, the weather was reported as clear or cloudy. Rain was reported in seven out of ten of the bad weather cases – snow and fog in the remainder. In twenty-six out of 100 fatal accidents, a driver or an adult pedestrian had been drinking alcoholic beverages, according to reports from twenty states. Drivers who reported as actually "being under the influence of alcohol" – the most serious violation included in the "had been drinking" category – averaged six out of 100 drivers in fatal accidents.

In a special three-year study in the State of Delaware, when special attention was given to the problem of the drinking driver, the percentage was found to be much higher. Blood tests were made whenever possible of persons injured in traffic accidents, and blood samples taken or intoximeter tests given to drivers involved unless they refused. In all cases where injuries were too severe to permit tests, or the driver refused to take them, the investigating officer recorded his opinion on whether the person had been drinking. As a result of this study it was found that out of a total of 138 drivers involved in ninety-seven fatal accidents, fifty-six (40.6 percent) "had been drinking."

The physical condition of the driver or pedestrian was sometimes listed as a possible contributing factor in fatal accidents. According to reports from twenty-one states, about one out of thirteen drivers was found to have had such a condition. Asleep or fatigue was the condition in two-thirds of these cases, with defective eyesight, illness, and defective hearing next in order of frequency. About one out of fourteen pedestrians killed had physical defects. Defective eyesight totalled one-fourth of the reported defects; hearing defects and illness were next in order.

Nonfatal injury accidents occurred in almost equal numbers in rural and urban areas, but the pattern of accident types was somewhat different from that in fatal accidents. Collisions with other motor vehicles accounted for over sixty percent of the injury-producing accidents, with a preponderance of these occurring in urban areas. In contrast, however, noncollision accidents producing

injuries occurred mostly in rural areas; this follows the same rural pattern for this type of accident as in fatal accidents. Pedestrian injury accidents occurred in an overwhelming proportion of the accidents in urban areas.

Table 4

TYPES OF MOTOR-VEHICLE ACCIDENTS PRODUCING NONFATAL INJURIES, 1955
(in thousands)

Type of accident	*Urban*	*Rural*	*Total*
Collision with:			
pedestrian	135.0	15.0	150.0
other motor vehicle	460.0	390.0	850.0
railroad train	3.5	2.0	5.5
street car	2.5	—	2.5
bicycle	27.0	3.0	30.0
animal, animal-drawn vehicle	1.0	4.0	5.0
fixed object	21.0	16.0	37.0
Noncollision	50.0	220.0	270.0
Total	700.0	650.0	1,350.0

SOURCE: National Safety Council.

The wealth of data above as to accident types, circumstances, driver violations, time of day, age and sex of driver, and the like, is provocative, and serves to whet our appetites for greater insight into causation.

Rural-Urban Accidents and Their Economic Costs

The United States is embarking upon the largest construction job it has ever conceived, the National Interstate and Defense Highway System, to cost $50 billion. As a result, there is greater pressure than ever for gaining a better understanding of the economic cost and rural-urban distribution of accidents. As mentioned earlier, the dollar cost of vehicular accidents in the United States in 1955 has been estimated at $4.5 billion. However, these estimates are based upon limited reporting and do not include a number of items of cost.

For this reason, a three-part study by the U. S. Bureau of Public Roads in co-operation with the State of Massachusetts represents a pioneering effort to gain a more precise understanding of accident

frequency, distribution and costs.[5] It focuses simultaneously upon the primary problems of concern to us here, population density, congestion and exposure.

By gathering together information about all accidents occurring on the highways of the State of Massachusetts for the year 1953, a grand total of 214,000 was recorded. This is a figure much higher than that reported to the police. We have previously noted that present records show a preponderance of fatal accidents for rural areas, while nonfatal injury-producing accidents are much more nearly evenly divided between urban and rural areas. When *all* accidents were taken into account in the Massachusetts survey, a dramatic reversal in these statistics was discovered.

With eighty-four percent of the state's population residing in urban areas, as defined by the Census, eighty-seven percent of all traffic accidents occurred in those areas. On a volume basis, therefore, almost nine out of ten accidents in the state occurred in the cities, towns and suburbs. Whereas the accident-to-population ratio for rural areas was only 1 : 49, for urban areas the ratio stood at 1 : 36.

Direct accident costs are now determined by multiplying the number of traffic deaths by an amount that represents one death, thirty-five personal injuries and 225 property-damage-only accidents. If information for Massachusetts proves typical for the nation, an important change in this formula may result. A distribution of accidents was made according to rural and urban, the latter according to a number of population class intervals. With the full data at hand, it was found that the ratio of fatal to nonfatal accidents was not 1 : 35 but 1 : 106 for the state as a whole. The ratio for all urban areas stood at 1 : 130. The ratio became 1 : 44 for rural areas and rose swiftly with each population class interval for urban areas from 1 : 60 to the highest ratio, that for the city of Boston, which reached 1 : 185. The ratio of death to property-damage-only accidents was found to increase with size of city in exactly the same manner: from 1 : 139 for rural areas to 1 : 469 for Boston. Statewide the ratio was about 1 : 310.

Let us now re-examine the cost formula in terms of dollars. In 1954 the number of deaths was multiplied by $110,000. This was

5. R. Dunham, U. S. Bureau of Public Roads, "The Economic Costs of Motor-Vehicle Accidents."

made up of $22,600 per death, $1250 per nonfatal injury, and $190 per property-damage-only accident. If, as a result of nationwide research, it should become evident that the fatal injury to nonfatal injury ratio should be substantially revised, let us say from 1 : 35 to 1 : 130, and the ratio to damage-only accidents from 1 : 225 to 1 : 310, the entire cost structure would have to be revised upward substantially.

The effect of such a new formula may be seen in the following calculations. In the new data one finds that "The average direct cost per fatal passenger car traffic accident is $5200, per personal injury it is $860, and for property-damage-only accidents the average is $200."[6] A new formula would give the following result:

1 fatality at $5,200	$ 5,200
130 nonfatal injuries at $860	111,800
310 property-damage accidents at $200	62,000
Total	$179,000

This produces a sum about sixty-three percent higher than the older formula. Applied to the present assumed cost of accidents of $4.5 billion this would yield a new total cost figure of $7.3 billion.

The new data for the cost of accidents on rural roads compared with costs on urban streets provide other revealing information. "The average annual direct cost of accidents per mile of rural roads is $400, on urban streets it is $4900. In other words, the average annual direct cost of passenger-car accidents per mile of road in urban areas is twelve times as great as it is in rural areas."[7]

Although the research referred to here is a new pioneering effort, it has already produced valuable results. Other studies in other states will naturally have to be done before it will be possible to generalize about the economic costs on a new, national basis. Moreover, the full value of the present data has yet to be exploited. It is reported that the unpublished data on the Massachusetts study include 437 tables providing detailed costs correlated with such accident characteristics as severity, location, type of accident, highway system, light, weather, and model of vehicle involved.

The first information available deals with direct costs only. Such costs include the money value of such items as: property

6. *Ibid.*, page 7.

7. *Ibid.*, page 9.

damage; hospitalization; doctors, dentists, and nursing service; medicine; damages awarded in excess of other direct costs; attorneys' services; court fees; and a number of small items. Neither the cost of truck accidents nor the indirect costs of automobile accidents, which make up the other two parts of the study, have yet been evaluated. Indirect costs, as a point of information, include the money value of loss of future earnings, overhead cost of accident insurance, driver training courses in the schools, safety engineering, traffic courts, traffic police and traffic accident prevention activities.

Although indirect costs have yet to be assessed, some indication of their magnitude is found in the fact that U.S. motorists carry automobile insurance valued at some $4.5 billion, that an estimated half the civil suits in the courts arise from traffic accidents and that urban traffic courts handle more than eleven million traffic violations each year.

Meanwhile, the survey has not only proved revealing in the details already made public but has also thoroughly documented an important general conclusion that has tended heretofore to remain somewhat obscure. In its own language, ". . . it is abundantly clear that the death-to-injury ratio increases as the population, congestion, and exposure increase."[8]

Important applications of the types of data already appearing are likely to be forthcoming. For example, they will re-enforce arguments for new roads and for types of roadway design considered to promote safety, will provide additional backing for more adequate patrolling of the highways, improved safety education, improved highway maintenance, better highway lighting and the like.

Highway Design Factors and Traffic Volume

Of all the corrective measures that may be taken to reduce accidents, few can produce such immediate results as those that involve non-human elements. For this reason, improvements in highway design present particularly hopeful possibilities for accident prevention.

Enough experience has accumulated to show the beneficial effect on accident rates of highways designed so that access to them by other vehicles is controlled. An excellent example is the Merritt

8. *Ibid.*, page 7.

Parkway in Connecticut, which fortunately for comparative work by the statistician, was placed parallel to U.S. Highway 1. The Merritt Parkway is a highway in which there is full control of access. This is defined as a roadway to which access is provided only with selected public roads and one for which crossings at grade and direct private driveway connections are prohibited. U.S. Highway 1, in contrast, is completely uncontrolled with respect to access. After twenty years of operation, the record shows that the high vehicle speeds and heavy traffic volume of the Merrit Parkway have been accommodated with accident and fatality rates only half as high as those found on Route 1.

The U.S. Bureau of Public Roads now maintains records for more than 2100 miles of streets and highways, classified according to full, partial and no control of access. Data for approximately 108,000 accidents, involving more than 2500 fatalities on these roads, have been compiled. These data have demonstrated the great safety advantages of the controlled access highway:

> The gross rates calculated show an average of 171 accidents per 100 million vehicle-miles of travel on highways with full control of access, and 408 for those with no access control. Based on accidents per 100 million miles of driving exposure, then, the highway with full control of access is nearly two and one-half times safer than the conventional highway without access control.[9]

There is an equally great saving in human life on controlled access highways as compared with other types of roads. The fatality rate on highways with full access control has been found to be only about one-third of that on highways with no access control.

Table 5

Control of access	*Number per 100 million vehicle miles Fatalities*
Full	2.8
Partial	9.6
None	8.0

Another unusual aspect of road design is the unusually high fatality rate (Table 5) on highways on which there is partial access

9. Charles W. Prisk, "Safety and Free Flow of Traffic," in a speech before the Sixth Highway Transportation Congress, Washington, D.C., May 9, 1956.

control.[10] One explanation that has been made of this situation is as follows: Where there is full access control, motorists are protected by the design of the road. Where there is no access control at all, motorists are constantly on guard against the possibility of conflicting traffic. But on roads where access is partially controlled, the driver is intermittently protected and intermittently exposed to interfering traffic, without an opportunity to become accustomed to either condition. As a result, although the total number of accidents that occur per 100 million vehicle miles is lower than that on highways with no form of access control, those that do occur are more severe and produce more fatalities.

The so-called "Freeway," the road with controlled access, effects a remarkable decrease in accidents involving head-on collisions (because opposing lanes of traffic are usually separated), angle collisions (because of the reduced number of points of entry), and collisions with pedestrians (because of limited access to the highway). On the other hand, rear-end collisions and same-direction collisions make up more than half the accidents in freeways. These accident types are said to be typical of the record on Germany's Autobahn, as well. Underlying driving situations that seem to be related to freeway accident problems are changes in speed when passing, the slowing down of trucks on hills, leaving and entering the freeway.

Highway shoulder widths and their correlation with accident rates have also been studied, but so far the evidence seems to be conflicting. One such study was concerned with one-mile road sections of the California state highway system in 1951 and 1952.[11] The roads were all in rural areas with 55 mph speed limits; had no substantial roadside development; were essentially straight and level; had no curves that significantly restricted speed or visibility; each had two lanes ten to twelve feet wide of bituminous or concrete pavement. Contrary to what might have been expected, it was found:

> . . . that the accident rate tended to increase with shoulder width, except at traffic volumes below 2000 vehicles per day, where the trend may be reversed.

10. E. H. Holmes, Deputy Commissioner, U. S. Bureau of Public Roads, "Accident Experience on Controlled Access Highways," Circular Memorandum No. F-2.22, April 25, 1955.

11. D. M. Belmont, "Accidents versus Width of Paved Shoulders on California Two-Lane Tangents, 1951 and 1952," Highway Research Board Bulletin 117, 1956, p. 1.

In another study of 9800 miles of straight rural roads in fifteen states, the results showed ". . . no indication that shoulder width, considered alone, has any bearing on the accident rates."[12] On the other hand, in a survey of 1169 miles of two-lane highways in the Interstate System, the Division of Highways of the California Department of Public Works pointed out what appeared to be a direct relationship between shoulder width and accidents:[13]

Table 6

Shoulder width	*Accident rate*
No shoulder	342
2–3 feet	250
4–5 feet	180
6–7 feet	180
8 or more feet	165

These findings contrast with a study in the State of Oregon. It found that there seemed to be no relationship between shoulder width and accident frequency on roads which had a volume of traffic less than 3600 per day.[14] However, a statistically reliable correlation was found between shoulder width and the occurrence of accidents for a traffic volume range of 3600 to 5500 vehicles per day. A limitation in the findings lies in the type of road originally studied, namely two-lane rural tangents.

The differences among the results of these studies point up the need for still additional research into the full meaning of the findings. For example: How do wide shoulders on different types of roads, such as freeways, affect accident rates? What elements of driver behavior influence the occurrence of accidents on different types of roads having different shoulder widths? Are paved shoulders normally utilized as part of the highway in some states or on some types of roads? Do local customs in the use of the highway and highway shoulders affect the possibility of accidents resulting from cars parking on or using the shoulders? Will larger samples studied over longer time periods give different results?

12. Morton S. Raff, "Interstate Highway-Accident Study," Highway Research Board Bulletin 74, 1953, page 28.

13. Carl E. Fritts, Vice-President, Automotive Safety Foundation, testimony before the Subcommittee on Roads, Public Works Committee of the U. S. Senate, published in *Public Safety*, May 1955.

14. W. A. Head and N. F. Kaestner, "The Relationship between Accident Data and the Width of Gravel Shoulders in Oregon," December 1, 1955.

Volume of traffic and its relationship to accident frequency was no object of particular investigation in the "Interstate Highway-Accident Study" referred to earlier.[15] Because of variations in the degree of completeness of reporting among the fifteen states which co-operated, accident rates were built according to three different methods. The Type I rate adjusts the accident data by means of a separate factor for each state, depending upon the degree of completeness in reporting believed to have been achieved. Type II rates include data for only those states that reported a total-to-fatal accident ratio of 1 : 25. Type III rates use data from all the participating states, without adjustment.

A general conclusion was that the amount of traffic had a great effect on the accident rate on tangent highway sections. At very high volumes, 10,000 or more vehicles per day, the accident rate usually dropped somewhat, probably because of congestion. The data were classified according to the different types of rates noted above and different types of roads. The author summarized his findings shown in Table 7 in the following words:

> As between the different types of roads at the same volumes, the conclusions depend on which type of accident rate is examined. Judged by the Type I rate, the safest roads at volumes below 10,000 vehicles per day are the four-lane divided roads without controlled access, followed closely by the two-lane roads; the four-lane divided roads are the worst in this volume range. Above 10,000 vehicles per day the four-lane divided roads with controlled access are far and away the safest, while the three-lane roads have much the highest accident rates.
>
> The Type III rates show little difference between road types for volumes under 5000 v.p.d., while the two-lane roads have the highest Type III rate for volumes between 5000 and 10,000. Above 10,000 the conclusion is the same as before: The three-lane roads are the most hazardous, while the controlled-access four-lane roads are the safest.
>
> The Type II rates are still different. Below 5000 the information is fragmentary. Between 5000 and 10,000 vehicles per day, the three-lane roads are the worst, while the four-lane divided roads without controlled access are the safest of those for which the samples are adequate. Above 10,000 vehicles per day the conclusion is the same as for the Types I and III rates.

Thus, we find evidence, conclusive in character, that the controlled access highway effects a marked reduction in fatal accident

15. Morton S. Raff, *supra.*

Table 7

ACCIDENT RATES ON TANGENTS, BY GRADE AND ROADWAY TYPE

Grade	*Two-lane roads*		*Three-lane roads*		*Four-lane roads*					
					Undivided		*Divided*[a]		*Controlled access*	
	No.	*Per million vehicle-miles*	*No.*	*Per million vehicle-miles*	*No.*	*Per million vehicle-miles*	*No.*	*Per million vehicle-miles*	*No.*	*Per million vehicle-miles*
TYPE 1 ACCIDENT RATES (ALL STATES, USING ADJUSTMENT FACTORS)										
Percent										
Less than 3	5,442	3.7	194	6.1	1,043	6.0	827	4.7	504	2.2
3–3.99	321	4.0	18	5.6	136	7.1	83	3.4	139	2.9
4–4.99	253	3.6	6	7.7	65	6.8	56	4.4	59	1.6
5–5.99	322	4.4	3	4.4	49	6.8	9	3.6	46	2.1
6–6.99	86	4.0	1	10.0	29	10.2	1	1.4	13	1.7
7 or more	49	3.9	5	14.4	26	10.1	6	15.6	13	1.5
Less than 3	5,442	3.7	194	6.1	1,043	6.0	827	4.7	504	2.2
3 or more	1,031	4.0	33	6.8	305	7.5	155	4.1	270	2.3
TYPE 2 ACCIDENT RATES (SELECTED STATES[b] WITHOUT ADJUSTMENT)										
Less than 3	3,507	3.0	100	6.5	644	3.3	701	3.0	504	1.6
3–3.99	219	3.3	14	3.4	78	3.5	78	2.5	139	1.7
4–4.99	175	2.7	1	1.2	12	2.0	43	3.0	59	1.5
5–5.99	259	4.2	0	0.0	18	3.7	6	1.8	46	1.4
6–6.99	50	2.9	0	—	0	—	1	2.5	13	1.6
7 or more	48	3.7	0	—	5	6.3	0	—	13	1.5
Less than 3	3,507	3.0	100	6.5	644	3.3	701	3.0	504	1.6
3 or more	751	3.4	15	2.7	113	3.4	128	2.6	270	1.6
TYPE 3 ACCIDENT RATES (ALL STATES, WITHOUT ADJUSTMENT)										
Less than 3	5,442	2.2	194	2.6	1,043	2.7	827	2.9	504	1.6
3–3.99	321	2.3	18	2.5	136	2.8	83	2.5	139	1.7
4–4.99	253	2.2	6	2.3	65	2.0	56	2.6	59	1.5
5–5.99	322	3.1	3	0.9	49	2.3	9	1.8	46	1.4
6–6.99	86	2.2	1	2.0	29	2.4	1	1.4	13	1.6
7 or more	49	3.7	5	3.1	26	2.6	6	3.3	13	1.5
Less than 3	5,442	2.2	194	2.6	1,043	2.7	827	2.9	504	1.6
3 or more	1,031	2.5	33	2.2	305	2.4	155	2.5	270	1.6

[a] Excluding highways with controlled access. This applies to all the tables.
[b] States having a total-to-fatal ratio of 25 or more. This applies to all the tables.

SOURCE: Morton S. Raff, "Interstate Highway-Accident Study," Highway Research Board Bulletin 74, 1953.

rates. With respect to the width of highway shoulders, however, the results of research have so far failed to develop a unanimity of opinion. On highway tangents, increased traffic volume leads to increased accident frequency, except at very high volumes, where congestion becomes so great that a decrease in freedom of movement leads to a decrease in accidents.

The Factor of Speed

There is a general impression in this country that high speed underlies a high proportion of highway accidents. This impression has been accentuated by the annual horsepower increase in new model cars. However, research completed to date does not appear to bear out this popular view.

First, it is generally appreciated that speed and the act of speeding are relative. It is one thing to drive at fifty miles an hour through congested traffic. It is quite another to drive at fifty miles an hour on a long, access-controlled freeway, where such a speed may be substantially slower than that traveled by other cars.

Based on data for the year 1955 available statewide for nineteen states, for urban areas in seven states and for rural areas in eleven states, it was found that of the drivers involved in fatal accidents about one-third were moving at fifty mph or more. The actual distribution appears in the table below:

Table 8

SPEEDS REPORTED IN FATAL ACCIDENTS

Speed (mph)	*Rural (%)*	*Urban (%)*	*Statewide (%)*
Standing	3	4	3
1–10	5	8	5
11–20	5	21	9
21–30	7	31	13
31–40	15	17	17
41–50	22	8	20
51–60	18	5	15
61–70	12	3	9
71 and over	13	3	9

SOURCE: The National Safety Council, 1956. *Accident Facts.*

It will be seen from this distribution that over half the speeds reported for rural fatal accidents was 41 mph or more, whereas more than seventy percent of the urban fatal accidents involved reported speeds of 40 mph or less. Care must be used in placing full faith in these figures since the speeds reported may not be reliable because evidence as to speed is obtained from the drivers or car occupants (before death or from the surviving driver or other persons in the car). Their judgments may not be accurate or their reports may be influenced by the conventional axiom that low speeds are safer.

Despite the fact that over a fifteen-year period the horsepower of American cars has in many instances doubled or more, maximum vehicle speeds have not shown the same growth. A comparison of speeds for twenty-one cars built in 1941 with the comparable models of 1956 cars was made at the proving grounds of the General Motors Corporation. All of the 1941 models were capable of speeds ranging from about 75 to 95 mph. The newer models demonstrated speeds of 75 to about 110 mph.[16]

A number of performance advantages have been cited for the newer cars. These include ability to: pass other cars and return to their own side of the road on two-lane highways quickly; accelerate through and thus clear intersections rapidly; blend more readily into existing traffic when entering limited access highways and expressways; provide a more uniform flow of traffic in hilly or mountainous country.

Proposals to limit vehicle horsepower and speed capabilities have not received wide support for the reasons noted above. Beyond this, there is some question whether these two vehicle characteristics predispose drivers to accidents. A study to be referred to more fully below concluded: ". . . if speed itself can be considered as having a direct bearing on accident rates, almost any standard production vehicle is capable of attaining dangerous speeds. To attempt to regulate speeds by limiting vehicle horsepower obviously would be unrealistic."

A highway speed investigation was undertaken at the Wilbur

16. Charles A. Chayne, Vice-President, General Motors, testimony before the Special Subcommittee on Traffic Safety, Committee on Interstate and Foreign Commerce, U. S. House of Representatives, 1956.

Cross Parkway in Connecticut, prompted by the thought that more important than the inherent speed capabilities of the vehicle is the manner in which it is driven.[17] More than 4000 observations were taken at selected points along the Parkway. These were classified according to speed, horsepower of the vehicles, and point of observation. As a result of these observations it was concluded that the driver rather than the vehicle was the key factor in determining highway speeds. Substantiating this position was a number of summary points:

1. The highest powered vehicles, while driven more frequently in the high speed ranges, are not driven at any greater maximum speeds than the lower-powered cars, except perhaps for those under 100 horsepower.
2. As the percentage of higher-powered vehicles on the highway increases, the average speed of traffic may be slightly increased.
3. The high-powered vehicles are better able to maintain desired speeds on steep grades and, because of their lower weight to horsepower ratio, have greater acceleration ability.
4. The vehicles with from 100 to 130 horsepower appear to be driven as fast as vehicles of any horsepower.
5. Inasmuch as vehicles of 100 to 130 horsepower are generally capable of maximum speeds in the range of 85 to 100 miles per hour it would appear that the critical factor in determining highway speeds is still the driver and not the vehicle.

If speed on the highway seems to bear a greater relationship to the driver than to the capabilities of the vehicle, does this imply that all drivers are speeders? Or does a particular segment of the driving public account for the highest speeds? The objective of research conducted in New York State was to answer these questions.[18] The data were obtained from spot-checks of automobile speeds and from a postcard survey based on vehicle registration. The conclusions were that higher speeds seemed to be associated with younger drivers, larger amounts of travel and newer cars. Beyond this, the fastest ten percent of the drivers provided a third of all speeds faster than the 85-percentile. However, when the set of

17. Robert E. Schmidt, "Highway Speeds vs. Horsepower," *Traffic Quarterly*, July 1954, Eno Foundation for Highway Traffic Control, Saugatuck, Conn.

18. B. A. Lefeve, "Speed Habits Observed on a Rural Highway," Proceedings of the Thirty-third Annual Meeting of the Highway Research Board; paper prepared by M. S. Raff, C. E. Billion, and E. C. Cross, Jr., 1954.

drivers was all observed as many as seven times, more than half exceeded the 85-percentile speed at least once. Even the driver whose average speed was equal to the overall average exceeded the 85-percentile speed about eleven percent of the time. Finally, the fastest fifteen percent of the drivers contributed forty-six percent of all the speeds over the 85-percentile speed.

The key question from the standpoint of our discussion here is not so much whether certain persons drive faster than others but rather whether there is a relationship between habitual fast driving and accident proneness. Research in the same state sheds some light, though not wholly conclusive, on our question.[19] As a result of examining accident records for drivers whose speeds had been checked, it was found that faster drivers have more accidents than slower drivers when judged by their speeds in the afternoon. However the obverse situation also appeared to be true, namely that drivers without accident records drove at higher speeds in the morning.

Thus it appears that a relationship between the fast driver and accident proneness has yet to be fully demonstrated. The New York projects, which were conducted with great care, stimulate us to raise questions about other segments of the problem. Are speed and accidents correlated among habitual users of other types of roadways than the rural, two-lane roads studied? Does normal fatigue at the end of the business day predispose drivers to speeding? Do the frustrations of the day influence their behavior and their proneness to accidents? These questions remain to be studied.

The Human Element in Highway Accidents

It is widely agreed that the principal causes of accidents are attributable to the human being, usually the driver of the vehicles. This belief is bolstered by indirect information such as that concerning the relatively minor role of unsafe conditions of vehicles involved in accidents. Unsafe vehicle conditions are involved in about eight percent of the reported accidents.[20]

19. B. A. Lefeve, "The Relation of Accidents to Speed Habits and Other Characteristics of Drivers," paper prepared by C. E. Billion and E. C. Cross, Jr., presented at the Thirty-fourth Annual Meeting of the Highway Research Board, January 1955.

20. *Accident Facts*, page 63, *supra*.

There is a fundamental assumption that the operator of a car bears primary responsibility for ability to handle the vehicle and to co-ordinate these functions with available roadway facilities, conditions of weather, traffic and other conditions. Inability of the driver to co-ordinate his skills with these conditions is presumed to lead to unsafe situations of the type that produce accidents.

A very large number of projects have concerned themselves with the physiological characteristics of the human being. These include his reaction time, his vision, his ability to co-ordinate physical functions in response to various types of stimuli. Simulator devices have been constructed in which the driver's ability to handle vehicles under simulated road conditions of traffic, unexpected occurrences, traffic control devices and the like had been tested. There is a very large literature on this subject which will not be described here.

However, a number of problems in the interpretation and application of the findings of such research have become apparent. First, the small samples in most laboratory experimental designs provide an inadequate statistical base for projecting the conclusions as generalizations about the driver population as a whole. Second, some believe there has been a certain "artificiality" in these experiments in that attempts to control the variables (necessary for such designs) have limited application of the information to laboratory conditions rather than to those found on the highway. Third, relatively little research has taken as its subject matter "the whole man," including the psychological and sociological factors that may be key motivations in accounting for his ability to drive safely in traffic.

Driving provides not only great freedom of movement and utility, but also places the individual in competition with others with the same objectives. In this sense, there is an analogy between driving and the pursuit of a vocation, in the exercise of one's rights as a citizen, participation in sports and other everyday life situations. Understandably, each of these is an extraordinarily complex situation, involving not only skills, physiological ability and learning but also the psychological and social drives that motivate human beings.

The result of these drives is formation of a set of attitudes which

greatly influence human behavior.[21] These include "attitudes toward traffic, toward the presence of other drivers, toward vehicle laws and regulations, toward enforcement activities, toward society."[22] How can we learn something about these attitudes? One method might be through application of motivation and attitude research techniques of the types utilized in marketing research.

Perhaps in this way we could also learn more about why people fail to report accidents, what their motivations are in particular kinds of trips, how they react to other drivers in the light of these and other motivations, what attitudes influence their behavior regarding particular road design features such as highway shoulders. With such information at hand we may be better able to provide the types of education, the kinds of vehicle and road design that will provide further safeguards against accident involvement. As yet this has remained an uncharted territory that holds great promise for pioneering research.

Accident Cause Classifications

If adequate data as to accident causes are to become available for accident prevention, they must be available in quantity and classified according to categories appropriate and applicable to the work of specialists in the various safety fields. Such fields include highway design, vehicle design, traffic control, enforcement, medicine, psychology, education and the like. Experience has demonstrated that development of an adequate system of cause classifications holds great promise for improvements in all aspects of safety data.[23]

A number of different approaches have been made to the development of adequate safety information. One of the most important of these relates to improvements in reporting by accident investigators. This is an effort which must receive continuing support. However, when one examines the mass of data already available about so many circumstances concerning accidents, one is

21. Ross A. McFarland, *et al.*, "Human Variables in Motor Accident Research," Harvard School of Public Health, 1955.

22. W. H. Cace and R. G. Stewart, "Driving Attitudes," *Traffic Quarterly*, July 1956.

23. For a delightful discussion of highway accident cause classifications, and application of data, see G. T. Bennett, "Highway Design in Relation to Road Accidents," given before the Institution of Highway Engineers (Great Britain), April 15, 1947.

struck by the scarcity of realistic information about accident causes. And although a great amount of diligence has been expended in the development of an international classification of causes of death, no comparable effort has been made to develop a classification system for cause of one of the leading causes of death, vehicular accidents.

The development of accident cause classifications in aviation provides a useful precedent for creative work in this field. At the beginning of World War II, causes attributable to the human being, usually the pilot, were grouped in a handful of categories. These included "carelessness," "poor technique," "poor judgment." Other categories, such as those involving the vehicle, airports, traffic control and the like, were equally general in character. At the time production of aircraft was being pushed to keep pace with the requirements for replacement of airplanes lost in accidents, and the demand for striking power in the air was growing. Those charged with accident prevention found they lacked the specific information for such action. They were at a loss to know what action to take to prevent repetitions of carelessness and poor technique. The entire personality of the pilot and his entire training program seemed to be involved. In short, the categories were so general in character that the specific technical indications for corrective action normally to be expected from the cause data were completely lacking.

As a consequence, a small group of analysts at the Air Force Office of Flying Safety set to work to develop more realistic categories from existing reports of accident investigations.[24] They started very simply by writing down in as few words as possible the facts reported about the occurrences. An innovation also worthy of note was that no attempt was made then or later to distinguish between "primary" or "secondary" causes, in the belief that such discrimination was not merely unrealistic but was, in point of fact, impossible. Moreover, diversity in the collection and classification of information was encouraged because various branches of the Air Force – the Training Command, the Air Materiel Command, the Weather Wing, etc. – were concerned with getting data relating to the areas of their responsibilities. The statements were briefed down

24. The author had the privilege of participating in this effort.

into skeletal form and made into sentences or phrases. When tested and revised for goodness of fit with hundreds and thousands of accident reports, these became the categories that were used for accident cause descriptions.

What did these look like? Instead of "carelessness" or "poor technique" one was likely to find: "Lost directional control in landing," "inadvertently retracted landing gear when intending to raise flaps," "not checked out in this make or model of aircraft," "failed to yield right of way to other aircraft landing," "exceeded placarded air speed." Detailed categories were developed for other aspects of accident causation, including mechanical troubles, airfield conditions, weather conditions, traffic control and the like.

These turned out to be meaningful categories for accident prevention because of their specificity. The cause system eventually numbered about one thousand categories. Still other categories were used for auxiliary information as to time, place, model of aircraft involved and the like. The data were also grouped so that the information could be summarized according to more general categories. All of the data were coded and handled by IBM methods.

The refreshing aspect of the data so classified was its great utility. The frequency of given causes became good guides as to their importance. Special study was given to causes in each category by specialists in various branches of the Air Force to determine the nature of the corrective action to be taken.

A number of other things was learned from this experience. It was found, for example, that a much greater wealth of information was obtained when investigators were asked to give a full account of each accident than when they were asked simply to classify cause information in the field. The central staff could be more highly trained and was able to classify information much more consistently than the much larger investigatory force. The specificity of the categories decreased the difficulty of finding suitable categories in which to classify the information.

The categories were found to have multiple applications. For example, a high rate of occurrences attributed to pilots and classified as "inadvertently retracted landing gear when intending to raise flaps" gave a good clue to the need for a specific type of pilot training and to the engineering problem respecting the placement, design

and method of operation of the landing gear and flap controls. Various difficulties in landing and takeoff were found curable through redesign of airports. Pilots who previously lost their way were later to be provided with better navigational and traffic control facilities. Best of all, accident reporting improved continuously because all hands came to have a sense of participation in the production of realistic and useful data.

Summarized data in the field of motor vehicle accident causes have yet to take on these characteristics of realism and usefulness. Hardly any system of causes attributable to drivers contains more than two dozen categories – despite the vast complexity of such causes. Information available today in accident reports, despite its inadequacy, tends to be lost almost entirely through lack of an appropriate system for handling the data.

Increasingly, accident data are centralized in municipal, county and state offices. Accident records have become the responsibility of a single individual or staff in these offices. At the same time, accident investigators are receiving training in government offices, professional societies and universities. The organizational framework exists for implementing a system of accident analysis, which, if applied nationally, could provide the realistic type of accident data so urgently required today.

Statistical Aspects of Accident Cause Research

There are a number of purely statistical aspects in accident cause research that may be touched on. Statistical techniques have progressed greatly from the mere accounting of accident facts. The perspective given by such techniques helps us to question certain assumptions more intelligently, gives us insights as to research needs, provides us with the methodology necessary for understanding accident problems.

One of the assumptions to be guarded against in accident research is the ability to generalize from small samples or from samples having unusual characteristics. A good illustration is found in the conflicting results of studies of roadway shoulder width mentioned earlier. If we had been able to assume that a sample of rural two-lane roads in a single state was sufficient, we might have accepted

a single study as a basis for conclusions about road shoulder widths throughout the United States.

As to research needs, we have become aware that many of our basic yardsticks require improvement. For example, we know now that we require better accident reporting, that the economic costs of accidents require study and that our passenger-mile data are subject to many deficiencies. We know that to understand the risks involved in different types of vehicle trips(to work, to shop, to vacation) we shall have to learn more about the extent of passenger exposure to such trips.

With respect to methodology, it has been brought to our attention that the relative importance of accident problems can be discerned through the establishment of rates and that rates can be compared with each other. Tests of significance can be applied to data resulting from repeated observations, so that we can discern whether differences in findings actually exist.

In a sense, accident data represent the results of a vast experiment in the interaction of men, machines, roads, and the weather. Statistical techniques will help us to understand the meaning of these results.

A Program for Accident Cause Research

We have touched on a number of points here concerning the magnitude of the accident problem, the types of accident that occur and some of the research that has already been completed. However, if we are to measure our results so far against the criterion of developing data for accident prevention, few of us can be satisfied with our progress. The many specialists in every phase of vehicle and highway design, in medicine, social science, and traffic and public administration require more solid data than they now have at their command.

Various research techniques, methods and subjects become apparent from the matters touched on here. These include the following:

1. Methods must be discovered for increasing the extent of accident reporting. Co-operation among enforcement officers, insurance companies, auto repair men and from the public must be

promoted to achieve greater reporting. If accident reports are kept confidential, not made available as evidence for legal actions, and if these facts are widely publicized, an important increase in the extent of reporting should result. Moreover, with the adoption of vehicle inspection laws in an increasing number of states, the terms of such legislation might be extended in such a way as to invalidate such inspection certificates when a vehicle has become involved in an accident. A new inspection would be required, thus providing an opportunity for obtaining a report of an accident.

2. National and international standards are required for definitions of accidents, injuries and fatalities so that the magnitude of the automobile accident problem may be more clearly revealed.

3. A more formal method for the interchange of information among accident research workers in various forms of transportation and industry is required so that each may have the benefit of the other's experience.

4. A better appreciation must be obtained of the impact of accidents upon society. Despite important steps forward already taken, measurements are required of the cost of traffic delays to other vehicles, the burden on the courts; the delays, training and retraining required in industry because of traffic accidents; the effect of loss of earnings through injuries and fatalities in accidents on the families of the injured or the deceased.

5. Improvements in the methods of classifying accident-cause information are long overdue. The full value of existing accident reports is therefore lost. Greater specificity is required in accident reports and in accident-cause classifications.

6. Socially-dimensioned studies are required to learn more about the motivations and attitudes of drivers. The more we learn about the man at the wheel the better will we be able to design a safer vehicle and a safer roadway for him, the better will we be able to educate him to the proper use of both of these.

7. More intensive study of highway design features in terms of their relationship to accidents is required. What is an adequate highway for a given traffic volume? How far ahead must the driver be able to see in order to react adequately to other cars, obstructions, curves? We must develop the required accident data to demonstrate their requirements.

8. We must learn whether there are local customs in the use of the roadway that influence driver behavior. If these exist, the discovery will influence our interpretation of research findings that are based upon study of local situations.

9. Motivations of drivers in making specific trips need to be known. Are they hurrying home after a difficult day at work? Are they attempting to make unduly long trips on holidays and weekends?

10. More adequate data on the amount of driving done, types and numbers of trips made, and travel routes taken, should be developed so that the basic yardsticks for the establishment of accident rates can be improved.

11. From the standpoint of developing data for long-range planning of road construction, a number of the studies suggested above can be combined with motivational studies that reveal future traffic loads. Where do people desire to live, to shop, to send their children to school, to work? Do people insist upon driving rather than traveling by public transit? Are these motivations influenced by prestige considerations relating to car ownership?

The above list is far from complete. It is intended primarily to point out a number of research areas that appear at this time to relate either directly or indirectly to the problem of gaining a better understanding of accident causation. Certainly the problem is so great that no research avenue that gives promise of contributing to that understanding should be neglected.

Regional Planning in Connecticut: The Next Step to the Future

ROBERT P. LEE AND WILLIAM BLAKEY

The Connecticut Development Commission of eleven members serves the state without compensation. Members of the commission are appointed by the Governor from the business, industrial, agricultural, and labor leadership. Robert P. Lee, Chairman of the Committee, is Area Development Director of the Connecticut Light and Power Company. The following article was prepared by Mr. Lee with the assistance of William Blakey, Chief of the Planning Division of the Development Commission.

THE Connecticut Development Commission was established in 1939 as an agency to promote the economic development of the state. Statutes direct that "The commission shall (a) study and investigate conditions affecting Connecticut industry, business, commerce, agriculture, recreational and residential facilities and promote and encourage the preservation, expansion and development of such industry, business, commerce, agriculture, recreational and residential facilities within and without the state; (b) promote and encourage the location and development of new industry, business, commerce, agriculture, recreational and residential facilities in the state; (c) collect, compile and disseminate information relative to the natural and economic resources of the state; (d) co-operate with promotional and research groups and associations, with agencies of the state and its political subdivisions and with agencies of the Federal Government and other states, in the execution of its duties; (e) furnish technical, secretarial and clerical assistance to the Tri-County Development Corporation and other non-profit corporations and organizations when it deems that the giving of such assistance shall promote the objects of this chapter."

While it was established to promote the economic development of the state, the general assembly recognized that this involved more than advertising and industrial promotion. The need for adequate research was recognized. Further, residential facilities and development were included in the scope of the research and promotion

duties of the commission. When the commission was established, economic development was recognized as a comprehensive problem.

Economic development, sound economic development, should be predicated upon the total environment. Not only did the state decide to "market" itself; it decided from the beginning that the agency charged with marketing must also assist in the work to improve the product to be marketed.

The commission recognized that its functions beyond promotion and advertising were limited. In Connecticut, as in the other New England states, the powers to plan for and control land usage, and to provide the essential services to land use were in the hands of the local governments. It was up to local government to provide land for industry in its zoning regulations, to provide essential sewerage and water supply, and so forth. The development of the state hinges upon the adequacy of the municipal planning and zoning programs of the 169 towns.

In its development work with cities and towns, more and more requests for assistance from local officials were related to land-use planning and land-use control, particularly zoning. In 1945, the first planning engineer on the staff was employed. It should be pointed out that the basic requirement for the position has been that the planners employed should have their experience and training in municipal planning.

Commission Assists Local Programs

Since 1945, the tremendous growth of the town planning and zoning program has made corresponding demands for advice and assistance upon the planning staff of the commission. Today, 121 cities and towns, making up more than ninety percent of the population of the state, have planning or zoning programs. The Federal Housing Act of 1954 required the development commission to be the state agency to administer the local planning assistance program of the housing and home finance agency. The special session of the general assembly in November of 1955, setting up the recovery program from the disastrous floods of that year, named the commission the agency to administer the local and regional planning assistance and flood redevelopment assistance programs.

The planning division of the commission has grown into a most important function of the development program of the state. It has also had to assume certain necessary administrative functions such as the federal planning assistance program.

The late Elmer R. Coburn, as chief of the planning and research division of the commission, was largely responsible for the success of the program. Through his able assistance, the commission kept abreast of changing times and changing conditions. In the early 1940's, he said that local planning alone was inadequate to carry out the economic development of the state. At that time local planning and zoning was limited to a small number of cities and towns. Suburbanization had not reached the state with full impact.

Mr. Coburn, foreseeing that the need of regional planning would be recognized by the state and local governments in the near future, urged that steps be taken to make regional planning possible. The 1947 session of the general assembly passed the first regional planning enabling legislation.

While the mechanics have been changed by amendments, the function remains the same. Section 868 of the 1949 revision of the general statutes directs that:

"Each regional planning authority shall make a plan of development for the region within its jurisdiction, showing its recommendations for the general use of the area including principal highways and freeways, bridges, airports, parks, playgrounds, recreational areas, schools, public institutions, public utilities and such other matters as, in the opinion of the authority, will be beneficial to the area.

"Any regional plan so developed shall be based on studies of physical, social, economic and governmental conditions and trends and shall be designed to promote with the greatest efficiency and economy the coordinated development of the region within its jurisdiction and the general welfare and prosperity of its people.

"It shall assist the planning commissions of the several towns, cities or boroughs within the area of its jurisdiction in carrying out any regional plan or plans developed by such authority."

The choice of the word "authority" is unfortunate. It implies administrative or supervisory powers, where in fact the *authority* is strictly an advisory function.

The original act specified that any two or more towns that had planning commissions could, by vote of their legislative bodies, join in the formation of a regional planning authority.

Shortly after the act was passed the regional planning authority of south central Connecticut, the New Haven area, was established. While an almost complete lack of funds severely limited its activities, it made two substantial contributions to the development of the region.

First, the participating municipalities jointly prepared a standard zoning regulation as a model approach to land use control.

Second, when the state highway department started planning the Connecticut turnpike express highway, towns along the proposed right-of-way in the region joined together through the authority to make representations to the highway commissioner on where the route should go. A more effective compromise was worked out by a co-operative approach through the offices of the regional planning authority.

Legislative Defects Corrected

However, there were several important weaknesses in the original legislation. The most important are listed below:

1. There was no requirement that in the first instance the regional planning authority be established for an area determined to be, in fact, a region. *Any* two or more contiguous towns could vote to establish an authority.

2. Where the statute required that the legislative body of each town (in a majority of cases town meeting) vote to join a regional planning authority there was no provision for initial leadership to serve as a catalyst to start any action.

3 No funds were available. Most cities and towns were so involved with rising taxes created by strictly local problems, such as the increasing costs of education, that local planning was having trouble in getting an adequate budget. The prospect of getting an adequate budget to support the local planning program *and* a regional planning program was remote. Local planning and zoning commissions, admitting the need of regional planning, were reluctant to take the necessary first step.

4. There was, and still is, general fear at the local level that voting to join a regional planning authority would result in relinquishment of local autonomy, in some measure, to a regional "supra government."

The Federal Housing Act of 1954 does much to resolve the money problem. It makes matching funds available on a fifty-fifty

basis. This has been a substantial inducement. Logic is fine but money still talks in town meetings with a strong persuasive voice.

The development commission, with the grass roots co-operation of the Connecticut Federation of Planning and Zoning Agencies, started several moves to correct other weaknesses. Legislation was prepared for the 1955 session of the general assembly which would require that:

1. Regional planning authorities for regions *as defined by the Connecticut Development Commission* could be established by vote of local legislative bodies, and

2. The development commission was directed to define the logical economic and planning regions of the state, initiate and promote the formation of regional planning authorities, and provide technical assistance to such regional planning authorities.

The Legislative Council of the State of Connecticut, made up of members of the senate and house of the general assembly, considered this legislation in its report dated December 6, 1954. This statement is of great importance, for it is made by elected representatives of the cities and towns in the state government:

"The Council appointed a sub-committee to meet with representatives of the Development Commission to discuss the merits of the proposed legislation. A meeting was held on May 25, 1954. At this meeting it was pointed out that Connecticut in recent years has experienced a phenomenal growth in population and in the adoption by local communities of land use controls (planning and zoning) so that approximately sixty percent of the state's total land area is under some form of public control, and ninety percent of its total population is living in these communities.

"It is claimed that growth problems affecting the state presently, however, are more often influenced by regional rather than local factors; that economic considerations have in large measure nullified our political boundaries with the result that there is a continuous shifting of manufacturing plants, other forms of business and residential development away from the congested centers and into the suburbs. The 1947 Regional Planning Act made it permissive for contiguous communities with planning commissions to meet jointly and prepare regional plans. However, there has been no authorization at the state level to define the logical economic regions for group planning. So far sufficient technical help has not been available for such regional groups to accomplish much more than token results.

"The proponents suggest that sound public procedure makes it plain that the state government must establish economic regions within the

state and provide adequate regional planning programs that will help our local planning and zoning officials in determining the best locations for manufacturing plants, shopping and residential areas, and otherwise directing the growth of their communities.

"The determination and establishment of economic regions, each comprising several towns, would also enable the state better to determine its own program of development, particularly in public works, highways, parks and other tangible services.

"The Council is of the opinion that the type of legislation proposed would in no way lessen local initiative or governing power and that it would in reality provide a broad background of technical information that would aid local planning officials in dealing with problems."[1]

In the regular and special sessions of the 1955 general assembly the proposed bills were passed. The 1957 session passed a bill appropriating $90,000 to enable the commission to define the regions of the state, encourage their establishment, and provide a limited amount of technical assistance.

Another bill of equal importance made it possible for towns making up sixty percent of the representation of a region defined by the commission to make an authority a fact, even though certain municipalities may hold out. (The regional planning law specifies that each municipality is entitled to have two members on the Board of the Authority, plus one member for each 50,000 people or fraction thereof over a population of 25,000 people.)

This is the status of regional planning legislation and efforts today. The result, however, has surprised even the most optimistic. Today, the development commission is having difficulty moving fast enough to satisfy the demands for action from several metropolitan areas of the state.

The Hartford, New Haven, Waterbury, and Bridgeport areas want to get started on regional planning authorities right away. The development commission has had the funds to do the essential, basic research work for only four months (as of October 31).

Commission Answers Questions

Here it is well to raise questions and make points that occur to the chairman of the development commission.

1. *Report of the Legislative Council*, State of Connecticut, December 6, 1954.

What is the "region" we are talking about? In discussing this question with staff planners of the commission there seems to be general agreement on the definition to serve the purposes of the statutes. The key to a definition is in the wording of the statute itself. Participation in the regional planning authority must be voted by the local legislative body. The regional authority which the municipality votes to enter into, therefore, must be clearly identifiable with local objectives and local problems. The so-called lineal city extending from Norfolk, Virginia, to Portland, Maine, is an academic exercise in the eyes of the Connecticut municipality considering regional planning. On the other hand, the town of Prospect could recognize and accept the fact that it has problems in common with the town of Middlebury and other towns in the central Naugatuck area surrounding the central city of Waterbury. The relationship and need of a joint approach to common problems is very real and practical at this level. The regions of the State of Connecticut will, therefore, be small in area.

A second question arises: "In a state as intensively urbanized as Connecticut, how can the development commission define regions whose boundaries are so uncertain and overlapping?" As an illustration, suppose that there were no South Central Connecticut Regional Planning Authority of which Milford is a member. Preliminary study indicates that that town is about equally divided in its orientation between Bridgeport and New Haven. Theoretically, the western half of the town probably should be in the Bridgeport oriented region and the eastern half in the New Haven oriented region. To divide the town, each part in a different region, is administratively impractical. In such cases, the only thing the development commission can do is to make as fair and objective a presentation as possible of the pertinent facts to the local government for them to make the final decision.

On the other hand, the commission could not bow to such municipal whimsy as a town in eastern Connecticut voting itself a member of a regional planning authority oriented to Danbury on the New York border. The boundaries of the economic and planning regions of the state will not be theoretically perfect. They will, however, be practical and workable.

This question does point up a logical next step in the planning

of the future development of the state. With its intensive urbanization and the blending of one region into another there is no sharp line separating one "region," as defined above, from another. It would appear, therefore, that at some time in the future an important function of the development commission will be to serve the several regional planning authorities by co-ordinating their efforts to resolve inter-regional problems. Do not confuse this suggestion with "state" planning. Rather, it means that the state should make available the resources and environment for a co-operative approach to these problems.

A third question is: "What will a regional planning agency do?" Getting away from the general language of the statutes, it would appear that regional planning has two important functions and one secondary possible function. Again, it should be pointed out that in Connecticut the minor civil divisions (there are no unincorporated areas) are legally and traditionally the units of government for controlling the use of land and provision of services to the users of the land.

County government is not a significant factor in Connecticut government. There are a few intertown agencies, such as the Metropolitan District Commission in the Hartford area, but they are not the rule.

What Regional Planning Offers

Regional planning is not intended or designed to lessen local initiative or governing power. Rather, it complements local government. In its report, the legislative council, as quoted above, described the intent of the statute. Regional planning "would in reality provide a broad background of technical information that would very substantially aid local planning officials in dealing with local problems." Local planning *and zoning* officials would be more appropriate terminology as under Connecticut law, in town government, the zoning commission legislates for zoning control.

1. Regional planning will provide a vehicle for a co-operative approach to common problems which do not stop at town lines. An example is in highway planning. Unfortunately, some highway designers approach the problem from a limited perspective which may be described as the "cut and fill" approach to highway loca-

tion. In other words, highway location is primarily determined by the nearest balance of cut and fill of land with its effect upon future land use development of secondary importance.

On the other hand, a strictly local approach to highway location would result in an absurd highway pattern, shockingly expensive, because municipal insularity would be the primary consideration. Regional planning would be an effective compromise between these two points of view.

2. Regional planning would provide to each municipality the perspective it needs in order to carry out a sound local planning and zoning program. If the future of a municipality is affected by conditions and events beyond its statutory boundaries, it must be aware of them. A question often asked of the commission is: "How much land should the municipality zone for industry?" This is not a problem that can be resolved within the boundaries of any one municipality according to a set formula.

Regional planning can determine with reasonable assurance the trend of the economy of an area for the foreseeable future. It can also translate these trends into the need of land areas for industrial, business, residential, recreational, and other development.

It can estimate the future population of the area. In a general way, regional planning can show the local planning and zoning commissions how their towns will be affected by the development of the region. Of the total acreage which may be needed for industry in an area, regional planning can assist the town by pointing out what acreage it has that is suitable and desirable for industrial development in general terms. The final decision to zone or not to zone the land is then up to the local commissions.

At the same time, regional planning should point out to town A that the industrial development taking place in towns B and C will probably increase town A's population by an estimated number.

Local government is lagging behind private enterprise in the regional approach to future development. To the industrialist, to the developer of a shopping center, to the public utility company, the town line is of little consequence in any consideration of labor markets, potential buying power, or future demands for telephone or electric service.

The home owner himself has a regional perspective of possible

employment, of where to shop, of where to find recreation, where to pick his friends. The future cannot be resolved with a kind of vision that stops at town lines.

There is a possible third function of regional planning that should not be overlooked. There is a serious shortage of competent planning technicians. Also, many towns do not have adequate funds to retain technical assistance, particularly on day to day administrative problems of zoning and subdivision control.

It may be that a regional agency, properly staffed, would not only do the general regional planning but, on a contractual basis with a town or towns in the region, do the detailed planning work so essential to a sound local planning and zoning program. The statute makes it possible if a municipality so wishes.

The General Statutes require that the development commission define the economic and planning regions of the state, to encourage and promote their establishment, and to provide technical assistance on a contractual basis. The 1957 session of the general assembly appropriated $90,000 to the commission to carry out those purposes. As far as has been determined, this is the first time any state has taken such a step. It is not a simple job to do.

Most of the work of defining the regions and encouraging their establishment will be done with the permanent planning staff of the commission supplemented by a temporary staff. Consultative assistance has been retained to advise the staff on methods.

While the appropriation is set up for the biennium 1957–1959, the commission does not anticipate dividing the entire state into regions and assigning each of the 169 towns to one particular region or another. Instead, several state-wide studies will be made of those factors which indicate community of interest. In some cases, the indication is direct and obvious, such as a map showing the town of residence of workers in the manufacturing centers of the state. In other cases, the common interest will be implied, as by a series of traffic volume maps.

Some of the material that has been compiled may be of doubtful value for defining economic regions, such as a map showing state senatorial districts. However, all known and available sources must be explored and evaluated.

General data are to be evaluated by the staff and preliminary

determination of regions will be made. The members of the commission were explicit in their policy instructions to the staff on this method.

Any determinations, even in the preliminary stages, are not to be made without the guidance of the representatives of the business, industrial, and governmental leadership of the state. In the near future, the commission will ask such men to serve on an advisory committee to meet with the staff and consider their preliminary findings. This will not be an "honorary" committee but a *working* group of advisors to the commission on this important problem.

When this preliminary step is completed, the commission will be ready to assist local efforts if and when the leadership of any area indicates the desire to consider regional planning. The commission staff will work with local leadership, making more detailed studies, to define the region specifically and promote a planning authority for that region.

At no time should it be inferred that the boundaries of the several regions were "handed down from Hartford." While the law says that regional planning authorities may be established for areas defined by the commission, local initiative and co-operation are the keys to the success or failure of this most essential next step to achieve economic development of the state.

Regional planning goes far beyond the problem of highway transportation. This nation is just starting upon an era of the industrial revolution of dramatic and far reaching consequences and highway transportation is a key factor. At the Symposium of "The New Highway: Challenge to the Metropolitan Region," sponsored by the Connecticut General Life Insurance Company at its new offices in Bloomfield, Connecticut, Lewis Mumford called events of the last thirty-seven years the suburban fall-out from the explosion of the central city.

The increasing mobility of the people and the economy of metropolitan America are revolutionizing the ways of living and earning a livelihood. Connecticut intends to do something about it.

The Seattle Freeway

W. A. BUGGE

Mr. Bugge has been Director of Highways for the Washington State Highway Commission since July 1949. Previously, since 1922, he served as an engineer for state and county governments and for private industry. He has served as president of the American Association of State Highway Officials, of the Washington State Association of County Engineers, and of the Western Association of State Highway Officials. He is Chairman of the Committee on Design Policies of the American Association of State Highway Officials, which formulated design policies for the 41,000-mile Interstate and Defense Highway System. He is a Director of the Highway Research Board of the National Academy of Sciences.

SEATTLE is suffering from acute traffic congestion. While the problem is much the same everywhere, the reasons for it and possible solutions usually differ from one city to another.

To handle anticipated 1975 traffic volumes on U.S. 99 (Interstate Route 5) through the city, a freeway is to be built with a variable cross section. The maximum section will contain twelve lanes, four of them reversible. This is an unusual solution.

To understand why such a solution is desirable and appropriate, it is necessary to have a general picture of the local problems involved. Seattle is shaped like an hourglass with Puget Sound on the west and Lake Washington on the east.

The central business district lies at the narrowest part of this hourglass and all north-south traffic must pass through this restricted corridor. The main residential area, as developed through the years, lies to the north with a considerable area to the east along the west shore of Lake Washington. At present, the area on the east side of Lake Washington is developing rapidly, with a large population increase also occurring to the south toward Tacoma. Complicating this attempt to solve a peculiar traffic problem is the fact that Seattle is a city of hills and thus there are a great many internal barriers to the development of freeways and streets for the north-south traffic.

The Lake Washington Ship Canal, connecting Puget Sound

and Lake Washington north of the business district, must be crossed – and here is another peculiar problem. Five bridges cross this canal and only one, the Aurora Avenue bridge, is a high-level structure. The others are subject to frequent openings to provide passage for water traffic between Puget Sound and Lake Washington.

Present Facilities Inadequate

Traffic now entering the city from the south divides into a number of four-to-six-lane streets leading toward downtown Seattle. All go through the industrial section where there is heavy truck traffic and heavy peak-hour automobile and bus traffic. Numerous traffic signals impede the free flow of vehicles. Through the central business area the principal streets carry heavy volumes; speeds during peak hours are limited to eight to ten miles per hour.

The Alaskan Way Viaduct, a part of which has been opened to traffic, is a six-lane double-deck freeway paralleling the waterfront and bypassing the downtown area. This has provided considerable relief. It is now being constructed further to the south. This extension of the viaduct will improve traffic conditions through the northern part of the industrial area.

On the north, the Alaskan Way Viaduct connects, through the Battery Street tunnel, with Aurora Avenue, the principal street leading to the north. The viaduct also makes connections to and from surface streets in the downtown area. Left turns have been eliminated on Aurora Avenue and reversible lanes are being used where traffic cones designate the reversible lane. Thus, four lanes are available during peak hours for the major traffic flow.

This arterial, along with the four other bridges crossing the canal, carry all the north-south traffic in Seattle. The only other highway that can be considered to provide any degree of relief for the north-south movement is the Interstate route to the east of Lake Washington. This makes a connection of sorts to U.S. 99 near the south and north boundaries of the urban area.

It carries through-traffic or vehicles not wishing to visit the downtown or industrial area of Seattle. But the use of this route requires excessive distance to travel. Also, since the proportion of through-trips through Seattle is rather small, this route on the east

side of Lake Washington will have practically no effect in providing relief in the central area of Seattle.

Before passage of the Federal-Aid Highway Act of 1956, it was considered possible to finance construction with normal motor vehicle funds by building short sections at a time. It soon became apparent, however, that the length of time would be too great. Thus steps were taken to finance the project as a toll road and considerable work was done by consulting engineers on the planning of such a facility. With the passage of the 1956 Federal-Aid Highway Act, however, it was considered possible and desirable to carry forward with the freeway plan.

Location a Result of Long Study

As might be expected, the location of the Seattle Freeway, in general, is not new; some portions of the location date back twenty-five or thirty years. However, the project as now proposed was actively initiated about ten years ago with an O & D survey.

Studies of this route have been carried on in one way or another since that time.

The O & D survey showed that the highway would serve the traffic in the industrial area and central business district by following the location along the hillside just east of the industrial area. This would provide a natural boundary separation between that section and the residential district east of the proposed freeway.

In the downtown area the route passes along the east edge of the central business district, leaving it virtually intact. The route provides a buffer between that district and the apartment house and residential area to the east. In making traffic assignments for this route, consideration was given to traffic in the north-south direction over the parallel surface streets, the Alaskan Way Viaduct and the proposed improvement for the Empire Way route.

This latter route, considering traffic needs, terrain, and crossing location at the Lake Washington Ship Canal, appears to be the only other facility that can be given consideration for improvement as a freeway. Such a route would, for the most part, be a six-lane expressway, becoming a freeway in the vicinity of the Lake Washington Ship Canal where the traffic demand is highest.

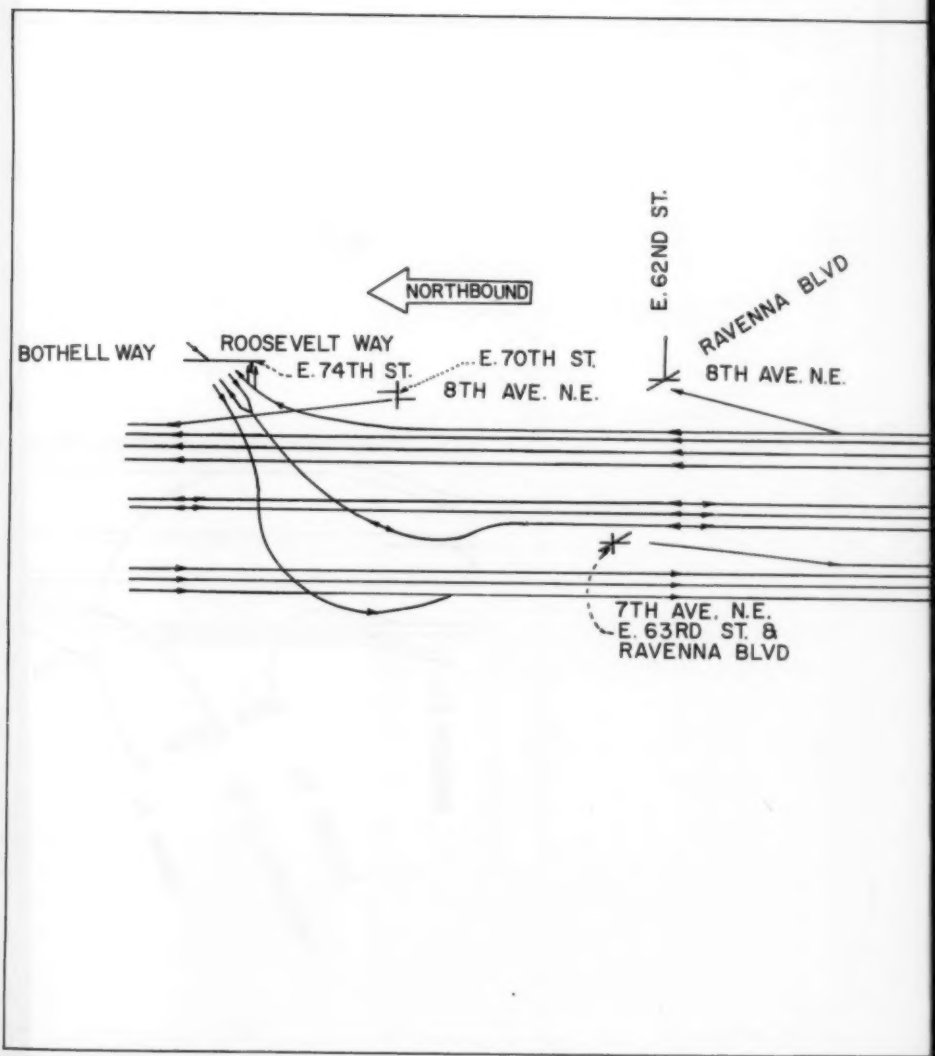
After assigning traffic to all existing and proposed routes that appear to be feasible, there was still a residue of an estimated 160,000 vehicles a day that would have to be handled by the new freeway. This volume in itself is only a general indication of the type of facility that is required; however, when it is broken down into peak-hour volumes for the maximum demand section just south of the Lake Washington Ship Canal, the directional distribution reaches an eighty-twenty split with a peak-hour volume assignment of almost 15,000 vehicles in the major direction of flow. To meet this demand fully, it would require at least ten lanes operating in the peak direction of travel.

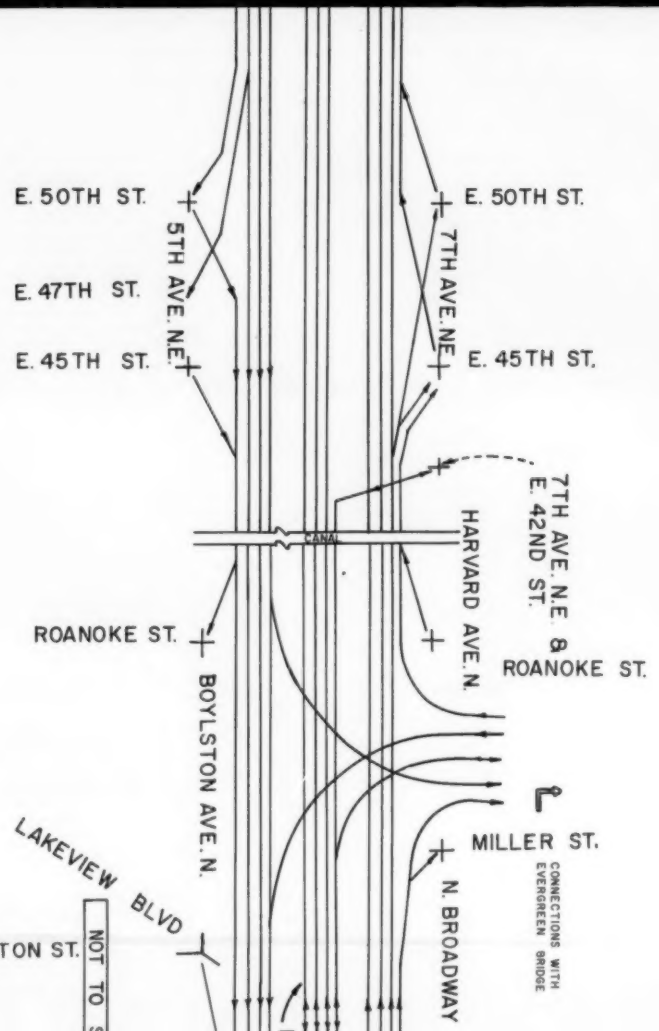
It has never been expected, in general, that any single freeway would handle such volumes as this, for it was thought that other routes could be developed to handle local movements better and at less cost per vehicle served. Due to the local conditions in Seattle, this is not the case. It is a basic concept that when a highway is constructed it should be designed to serve the total traffic demand in the most economical manner. Thus the decision was made in Seattle to locate and to design the facility to meet as nearly as possible the traffic demand in 1975.

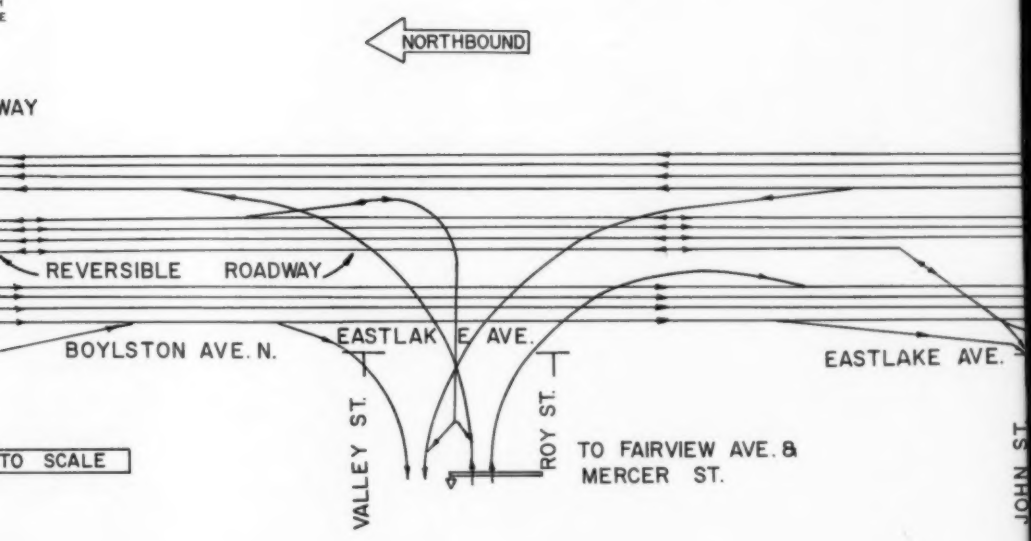
The use of reversible lanes to handle unbalanced traffic flow is not new. It has been used in many instances on surface streets and on bridges to permit a greater number of lanes in the major direction of travel. In some instances the entire flow on a single street has been reversed. The usual regulation is accomplished by signals over the appropriate lanes, by portable stanchions or by barricades. On the Aurora Avenue bridge, average volumes in excess of 1500 vehicles per lane per hour are being handled on lanes that are only nine-and-a-half feet wide, with an accident rate that is comparable to other arterial streets. These operating conditions, however, are not considered to be satisfactory.

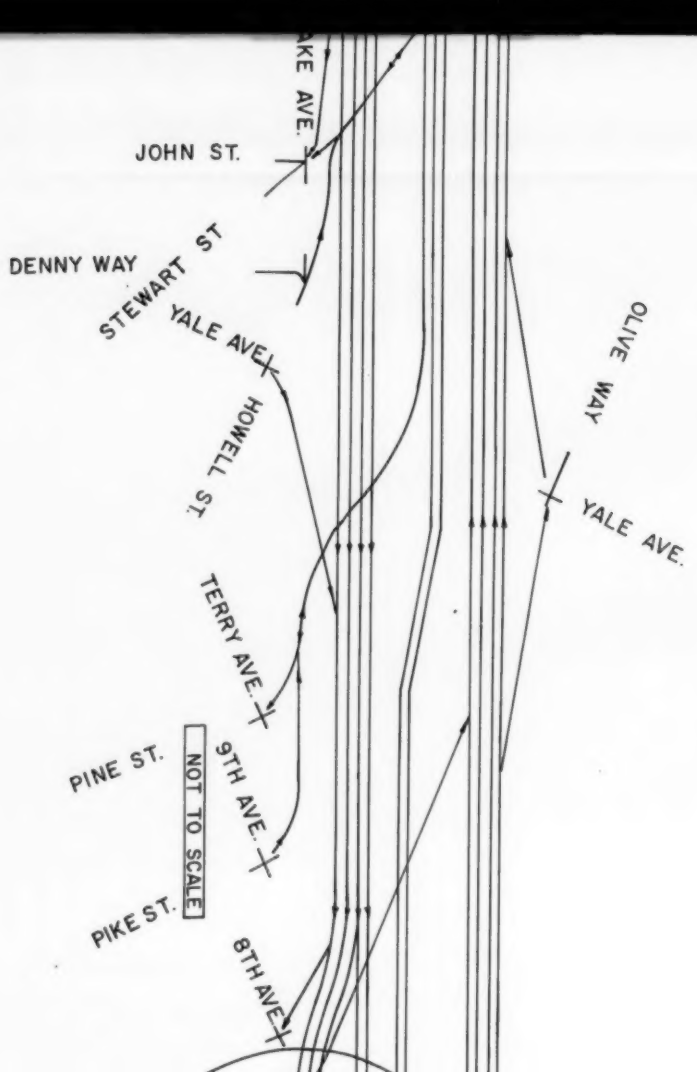
Independent Reversible Roadway

During the early stages of the Seattle Freeway design it was proposed to improve on this type of layout by actually constructing an independent reversible roadway. This had never been done on a freeway and a great deal of interest was stimulated, particularly


NORTHBOUND
E. 62ND ST.
RAVENNA BLVD
BOTHELL WAY
ROOSEVELT WAY
E. 74TH ST.
E. 70TH ST.
8TH AVE. N.E.
8TH AVE. N.E.
7TH AVE. N.E.
E. 63RD ST. &
RAVENNA BLVD


E. 50TH ST.
5TH AVE. N.E.
E. 47TH ST.
E. 45TH ST.
E. 50TH ST.
7TH AVE. NE
E. 45TH ST.
7TH AVE. N.E. & E. 42ND ST.
CANAL
HARVARD AVE. N.
ROANOKE ST.
BOYLSTON AVE. N.
ROANOKE ST.
MILLER ST.
LAKEVIEW BLVD
E. NEWTON ST.
NOT TO SCALE
N. BROADWAY
CONNECTIONS WITH EVERGREEN BRIDGE

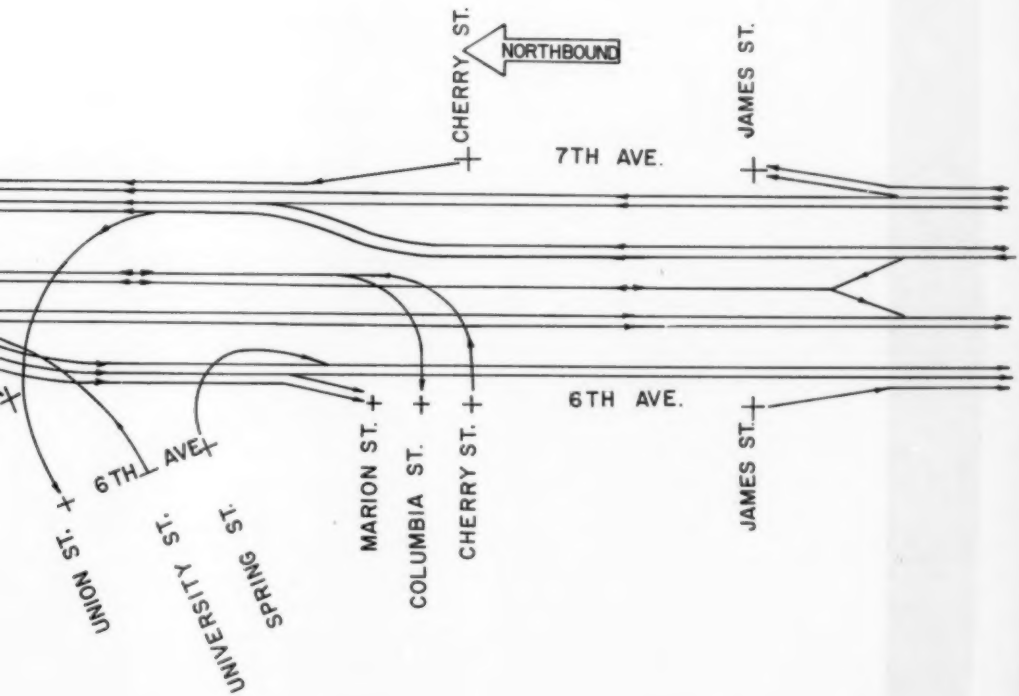

NORTHBOUND
WAY
REVERSIBLE ROADWAY
BOYLSTON AVE. N.
EASTLAKE AVE.
EASTLAKE AVE.
VALLEY ST.
ROY ST.
TO FAIRVIEW AVE. & MERCER ST.
TO SCALE
JOHN ST.


KE AVE.
JOHN ST.
DENNY WAY
STEWART ST
YALE AVE
HOWELL ST
TERRY AVE.
PINE ST.
9TH AVE.
PIKE ST.
8TH AVE
NOT TO SCALE
OLIVE WAY
YALE AVE.

US 99

SEATTLE FREEWAY

SCHEMATIC DIAGRAM OF LANES
SEPT. 30, 1957



with the staff of the Bureau of Public Roads. Conferences were held with the Bureau and an initial design was made on the basis of three roadway sections consisting of two three-lane unidirectional roadways and a center two-lane reversible roadway. This would provide for a five-eighths or approximately sixty-five percent directional split during peak periods.

In this design, transfer points were provided to allow cross-over movements between unidirectional and reversible roadways. Vehicles on the reversible lanes would transfer to the outer roadway and then proceed off the freeway at the desired interchanges. Because of the large number of interchange ramps it would have been necessary to weave large numbers of vehicles more or less continuously with the accompanying hazards involved and thus would void much of the supposed advantages of such a facility. Therefore, a two-lane reversible middle roadway having access only at its extremities was considered.

When analyzed, this worked out nicely as it was considered possible to load completely the two express or reversible lanes with traffic originating in the downtown area and having destinations some five miles north at or beyond Ravenna Boulevard. The toll road consultants agreed essentially with the basic design for using reversible lanes. However, the volumes were estimated to be somewhat higher even as a toll road and it was proposed to increase the number of lanes in the maximum section to ten lanes, four of which were to be reversible. This plan then proposed two three-lane unidirectional outer roadways and two two-lane reversible roadways in the center. This required traffic transfer points between the two as proposed in the original plan and would be an objectionable feature particularly when the highway reverted to a freeway and the toll collection plazas were eliminated.

Now a Freeway

With the return of the project to a freeway status, it was apparent that a new comprehensive traffic analysis should be undertaken as the O & D data were ten years old. This analysis included new routes that had been constructed, improvements made or contemplated on existing streets, changes in land usage and trends in

vehicle registration. The results of this study, of course, did nothing to ease the design problems as the result showed an increase in the anticipated traffic volumes to be handled. However, these data were used to analyze the type of facility which would be required on the various sections and to make alternate layouts that would provide continuity and would meet the traffic demands. By providing a variable cross section with regard to the number of through-lanes, some of which begin and end at major ramps, some used in reverse-lane plan, a close approach is made to a "design-to-fit traffic."

A major consideration in this plan was the width of right of way to be taken. The route as proposed, even as close as it is to the central business area, requires the taking of no major buildings. However, any increase in right of way requirements over previous proposals for a nominal one-block width would raise the cost of acquisition out of proportion to the benefits gained. In addition, the existing streets such a plan would take out of operation are essential to the proper functioning of the surface street system.

The result of this study indicated that, through the section where the maximum number of lanes was required, a three-roadway section with two four-lane unidirectional roadways and one four-lane reversible roadway would best fit the traffic pattern. While some other combination might have fitted the above requirements, it was believed from freeway experience that no more than four lanes should be used on any one roadway to obtain the most satisfactory operating characteristics.

Under this plan the number of reversible lanes would be variable with two, three and four lanes provided between James Street at the southern boundary of the central business district, where the directional peak-hour traffic distribution is a sixty-forty split, and extending to East 110th Street, where the directional distribution is eighty-four-sixteen, a distance of about seven miles.

A diagrammatic sketch showing the freeway interchange ramp connections is shown in Figure 1.

Connections are Planned

This plan goes further than any of those previously proposed for it provides connections to the reversible lanes in the peak direction

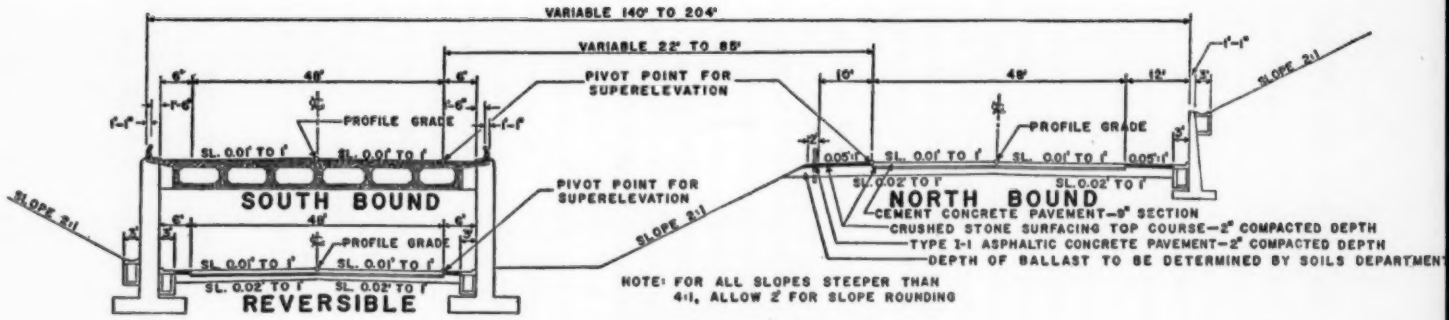

VARIABLE 140' TO 204'
VARIABLE 22' TO 85'
PIVOT POINT FOR SUPERELEVATION
PROFILE GRADE
SL. 0.01' TO 1'
SL. 0.01' TO 1'
SOUTH BOUND
PIVOT POINT FOR SUPERELEVATION
SLOPE 2:1
SLOPE 2:1
PROFILE GRADE
SL. 0.01' TO 1'
SL. 0.01' TO 1'
SL. 0.02' TO 1'
SL. 0.02' TO 1'
REVERSIBLE
PROFILE GRADE
SL. 0.01' TO 1'
SL. 0.01' TO 1'
SL. 0.02' TO 1'
SL. 0.02' TO 1'
NORTH BOUND
SLOPE 2:1
CEMENT CONCRETE PAVEMENT-9" SECTION
CRUSHED STONE SURFACING TOP COURSE-2" COMPACTED DEPTH
TYPE 1-1 ASPHALTIC CONCRETE PAVEMENT-2" COMPACTED DEPTH
DEPTH OF BALLAST TO BE DETERMINED BY SOILS DEPARTMENT
NOTE: FOR ALL SLOPES STEEPER THAN 4:1, ALLOW 2' FOR SLOPE ROUNDING

Figure 1. Roadway section

of travel for each of the same interchange areas as provided for in the unidirectional lanes. In addition, connections are made from the unidirectional lanes at the north and south extremities by dropping one lane from one set and adding it to the other. A certain portion of the traffic during the peak-hour is able to pass completely through this area or to leave in the vicinity of any other interchange with a minimum amount of interference.

This in effect amounts to superimposing an additional freeway in the same right of way and permits connections to a completely different set of streets. By alternating the ramp connections between the unidirectional lanes and the reversible lanes a much greater use is made of the street system for collection and dispersion of traffic.

In order to comply with the imposed right of way limitation the reversible lanes are carried under either the northbound or the southbound lanes through the central business district. Besides requiring the least amount of right of way, this plan also makes it possible to make better connections to the streets from the reversible lanes. Even with this twelve-lane section it is not possible to provide fully for the 1975 traffic demand in the section between Denny Way, at the north end of the central business district, and East 45th Street, just north of the Lake Washington Ship Canal, about three miles.

In making the necessary number of connections to and from the local street system to use the capacity of twelve lanes on the freeway, it is undesirable, if not impossible, to make further additions to the ramp system. It is a basic principle in the design of this freeway that the ramps and connections to the street system must be developed to operate efficiently and smoothly under the assigned traffic load. The biggest problem in this connection lies in providing adequate capacity at the ramp terminals and determining whether the local street system is capable of handling the volumes beyond the ramp terminal. Other than the elimination of parking in the vicinity of the ramp terminals and the introduction of additional one-way streets to the system, no serious difficulties have been encountered.

Standards are High

Standards on the freeway must obviously be the very highest. Grades on the freeway itself are generally limited to three percent

upgrade and four percent downgrade for the unidirectional lanes, with a maximum plus grade of three-and-a-half percent occurring only at one location south of the central business district. Reversible lanes, of course, will have a maximum plus grade of four percent where they fall below either the north- or southbound lanes with such a grade.

Curvature on the freeway is limited to three degrees and thirty minutes. Design speed is sixty miles per hour except for a short section in the downtown area where vertical curve controls limit the design speed to fifty miles per hour. Medians between separate roadways are laid out to provide ten-foot shoulders on both the right and left with a positive barrier of the guard rail type in the middle. This will enable all disabled vehicles to get off the through-lanes as rapidly as possible and thus to cause the least amount of interference to the through-traffic.

Because there are several long structures of the viaduct type where the reversible lanes are carried underneath, it is proposed to use a six-foot shoulder on both the right and left for any structure over 150 feet in length. This width will provide sufficient room for the normal lanes to pass with only the interference and inconvenience of leaving the striped lanes to reduce the flow of traffic. Ramps are of the parallel type either as used in directional or diamond type connections.

Design speeds for vertical curves on ramps where they enter or leave the highway are for a minimum of forty miles per hour. The horizontal curvature in most cases allows a thirty-five miles per hour design speed, but in a few critical locations it is reduced to twenty-five miles per hour. As these ramps have a long deceleration lane there is ample time for reduction in speed before entering the curve so there will be no adverse effect on freeway traffic.

A major problem occurs in providing satisfactory ramp grades. The freeway passes along a rather steep hillside and city streets have grades up to eighteen percent. With these imposed conditions at most ramp terminals, it is not reasonable or desirable to go to extremes to maintain flat grades, particularly as the local residents have trained themselves to operate under these adverse conditions. It has been possible to hold to a maximum of eight percent, although many ramps have six percent and seven percent grades.

Incomplete studies of vehicle-headways on ascending grades in Seattle indicate such grades will probably not seriously affect the ramp capacity where the percent of commercial vehicles is relatively low. However, all ramp capacities used in analyses were computed from data published by the Bureau of Public Roads. In actual practice, ramps and streets will be capable of carrying greater volumes than those computed for their capacities.

No definite conclusion has been reached as to the total length of time during the day that the reversible lanes should be open for traffic. It is estimated, however, that by 1975 the reversible lanes would have to be in operation from 6 A.M. to 10 A.M. for southbound traffic and from 2 P.M. to 8 P.M. for northbound traffic.

There are probably other hours when this operation would be desirable in order to provide better operating conditions on the unidirectional lanes. A shutdown of at least an hour should be allowed when changing the direction of flow to give ample time for the traffic to clear and to make a visual inspection to insure no vehicles will be left on the roadway.

On and Off Movements from Reversible Lanes

A big question always raised concerning the use of reversible lanes is the control of off and on movements at the terminal points. Three types of problems are encountered. One occurs at the north and south terminals of the reversible lanes where a lane of the freeway is transferred to the reversible lane section. Another where the lane terminates in a couplet to the one-way street system. And last, where the connection is made to a two-way road.

The latter involves cost problems, but by making the reversible lanes connect in the center of the local road and by carrying the median ahead, the problem is considerably simplified. Although no actual designs have been made, it will be possible in all cases to provide positive control by opening and closing gates to force traffic into the proper pattern. It probably will not be possible to use the same controls at all locations but they should be of an overhead type and no doubt can be fairly well standardized. Such positive control would also be supplemented by stop signals and signs using changeable messages. The signs along the reversible

lanes themselves would offer no particular problem and would follow a pattern similar to signing on the regular lanes except that messages would be required on each side to conform with the direction of traffic flow. The remote control of all gates, changeable signs, and signals should be possible from a central operational control office, supplemented by manual control at the site to take care of any emergencies that might arise.

Despite all the care that can be exercised in the design of the freeway and its connections, there will eventually come a day when it is inadequate and becomes congested. This may occur by changes in driving habits, changes in population centers that could not be anticipated, variances in traffic forecasting, or the accumulation of normal traffic increase over a period of years. This has happened with almost all freeways that have been constructed in the past, and it will occur with all of them at some time in the future. Because of the tremendous sums of money that have been and will be spent to provide for such high-type facilities, it becomes more and more important to see that they will carry out their intended purpose permanently.

To do this means that someday the traffic on the freeway at the various ramps must be metered so the freeway traffic itself will operate smoothly and efficiently at the optimum volumes. Equipment to count and control traffic in this manner is being developed and will be in general use before long. It can certainly be expected that such control will be required by the year 1975 on the Seattle Freeway even with the contruction of twelve lanes.

There is no need, however, to include provision for such devices in the plan at present, as there will, no doubt, be many improvements and changes in years to come. In the meantime, Washington engineers are certain that this highway, as proposed, will provide the best traffic service at the lowest cost for the vehicles served.

Safe Movement Plans Are Discussed For Emergency Vehicles

RICHARD C. LEE

Richard C. Lee has been Mayor of the City of New Haven since January 1954. Prior to that he was Director of the Yale News Bureau. He has served on New Haven's Board of Aldermen and the City Plan Commission. His leadership in solving city problems of redevelopment, renewal, traffic, and parking has attracted nationwide attention.

THE morning of December 15, 1953 began like any other normal day for New Haven's city government. There were the usual routine of business to be carried out by city departments, the usual calls for assistance or emergency aid flowing to the departments of fire service and police service. Suddenly, at 9:22 A.M. an alarm sounded in the fire alarm quarters demanding dispatch of engine and truck companies. Simultaneously, in a different sector, the deputy chief's radio crackled a similar message, instructing him to proceed to the fire.

The paths of these vehicles converging to the location of the fire were to cross at one of the most heavily traveled intersections in the city. Abruptly, at 9:24 A.M., a screeching of brakes preceded roaring, tearing, impact sounds. Two vehicles had collided!

The scene was appalling. The fire apparatus struck the deputy's car broadside at a point in the intersection where the two vehicles were to have crossed. In seconds, as vehicles careened about the intersection, three passenger cars were smashed and the fire apparatus mounted the sidewalk and struck an adjacent building. The tragic result – a deputy chief and a fire captain fatally injured, several firemen and civilians seriously injured, months of lost time to those involved, and more than $200,000 cost to the city.

Why did it happen?

The tragedy occurred just two weeks before I was to take office in my first term as Mayor. It was a grim reminder that the mayor of any city has the responsibility to search for the solution of many problems. In this instance, I was cognizant of the high level of

efficiency of New Haven's fire service. I knew that our firemen were carefully and fully trained in the techniques of driving swiftly but safely to fires.

In the ensuing months, I gave thought whenever possible to the solution of this perplexing question. How could we make the travel of emergency vehicles through our streets safer and more certain? Our fire and police departments were acquainted with some of the techniques of pre-set fire lanes. Some experimentation with fire lanes had been carried out at test intersections. Finally, it was learned that a small mid-western city had installed a new device providing individual control of signalized intersections by emergency equipment. Upon learning of this, I appointed the fire chief, police chief, and traffic engineer to look into the methods of safe movement for emergency vehicles, and to investigate the new system.

During 1955, these men gathered information on types of installation. Before the year's end they decided that the individual-type control was what they desired. In September of 1955, they visited a nearby city that had a trial installation in place. By the end of October, they placed a trial installation at one intersection in New Haven. In the meantime, I proceeded with such information as they furnished me to provide funds. A sum of $20,000 was made available for expenditure on this type equipment during 1956. Incidentally, at the same time, I accepted gratefully – from an anonymous local resident – a donation of $5,000 to be applied toward such equipment. Finally in February 1956, the traffic engineer and the two chiefs recommended the purchase of equipment that was subsequently installed.

Plan of Action

The recommendation of the group called for protection of forty-three out of one hundred and ninety signalized intersections in the City of New Haven. It called for simultaneous protection of all fire department vehicles, both fire-fighting apparatus and passenger vehicles, totaling twenty-five. The recommendation stated that this was to be the first stage of a three stage program. It recommended further that the second stage should include all police

department vehicles, and such additional intersections as funds were available for.

The final stage would entail protecting all remaining intersections. The purpose of staging was twofold. First, there was the obvious desirability of spreading the cost over several years if this were feasible and not harmful to the program. Second, there were considerations of public opinion and reaction to account for. It was considered that staging would give the public time to become accustomed to the system as it expanded. Finally, it would give the protective services time to become familiar in the use and maintenance of the system.

Fire Department Selected: The fire department was chosen for the first installation because it was believed that with their heavier apparatus the potential losses and risk of injury were somewhat greater than for police vehicles. It was deemed essential that the entire staff of the service selected be equipped at once. It would not be practical to partially equip either or both services.

Selection of Intersections: The proper selection of a priority list of intersections to signalize the first control was given very careful study. It appeared that the signal system of the city might be defined to lie in three rings. The central ring is, of course, the central business district. Here, virtually every intersection is signalized and the distance between signals is generally four or five hundred feet. In this area, travel speeds even for emergency vehicles, are necessarily quite low. An outer ring exists in residential areas near the city limits. Here are found isolated signalized intersections. These intersections, naturally, have the lowest frequency of traverse by emergency vehicles because of the relatively lower densities of population and buildings in that area. The middle ring appeared to be the one of most concern.

The "Middle Ring"

This ring contains the densely settled residential areas and heavily traveled commercial arteries of the city. The signals in this area are found primarily along the arteries where traffic volumes are heavy, and congestion occurs at times. These are the locations where it was felt the greatest frequency of traverse at relatively high speeds would be found.

Figure 1. Electronic Signal Locations

Figure 2. Equipment routes on day of fire.

Accordingly, the signal locations shown in Figure 1, forty-three in number, were selected for the initial stage of protection. This initial protective stage, for twenty-five vehicles and forty-three intersections, was put into operation June 29, 1956. It was the largest installation of that type equipment in any city at that time. Its inauguration was viewed by police, fire and traffic officials from many cities throughout New England and the Atlantic states.

Operational Characteristics: The equipment and principles involved in the system adopted in New Haven are relatively simple. Each emergency vehicle carries its own transmitter and transmitting antenna. This transmitter is capable of sending two alternate signals: one for use when the vehicle is traveling in a north-south direction, the other when traveling in an east-west direction.

At each intersection to be protected there is a radio receiver and a receiving antenna. It responds only to calls from the emergency transmitters. There is also located at each intersection, in clear view near the regular signal head, a beacon light. As presently used in New Haven, the approach of a protected emergency vehicle from any direction causes the receiver at the intersection to take control of the signal lights away from the standard traffic signal controller. The receiver then operates a sequence in which the "red" showing on whatever street it happens to be located is locked in place. The "green" showing on the other street changes to rapid flashing amber (caution) for three seconds and then to "red" which locks in place. If the emergency vehicle is traveling north-south, the beacon light is activated and starts rotating and flashing.

This setup is held until the emergency vehicle has passed through the intersection and the receiver no longer is receiving from the transmitter. At that time, the receiver drops out and the traffic signal controller picks up whatever cycle phase it would be in at the time. Under this system, north-south emergency vehicles have priority. Any east-west emergency vehicle approaching the intersection will know if the beacon is flashing that there is a north-south emergency vehicle approaching also and will give way to it. Civilian vehicles, of course, are obliged to obey the "red" indication on all approaches and stop and await passage of the emergency vehicle.

A special adaptation of this system exists on one-way streets.

On these streets it is recognized that the stopping of civilian vehicles all proceeding in the same direction and, therefore, occupying the entire roadway could prevent passage of emergency vehicles also traveling in that direction. For one-way streets, the signal indication for that direction is locked in the "green" showing. Under these conditions, civilian vehicles proceed through the intersection and then pull to the right and stop, as they are normally required to do.

Performance: This operating system has been found to work satisfactorily. However, from comment received from drivers of the fire service and civilians, it leaves some doubt as to whether or not the system has been activated and is properly functioning when an east-west emergency vehicle approaches because, in this instance, the beacon light does not flash. To the public it is the flashing beacon light that says "this intersection is reserved for the imminent passage of an emergency vehicle." For this reason, a change in operation has been devised and will be undertaken in New Haven in the near future. In that operation, neither the east-west nor north-south vehicle will have preference, but instead the first vehicle-driver to activate the intersection will lock it to his direction.

He will be given a "green" showing and the crossing traffic will be given a "red" showing and the beacon will flash in all instances. Under this system, civilian drivers will always know that the intersection is being controlled. At the same time, emergency apparatus drivers approaching with the intersections controlled adversely against them by another emergency vehicle will know that they must give way, because they have not received the "green" showing.

Regardless of the specifics of the operation as detailed above, it is apparent that here is a system which provides positive information that emergency vehicles are about to make passage. It does not negate the basic requirements of cautious behavior on the drivers. It does not negate responsibility of civilian drivers to pull over to the edge of the roadway and stop. It does, we sincerely believe, greatly reduce the possibility of collision in the intersection, particularly between emergency vehicles whose paths are crossing.

An important point in the selection of this equipment is the fact that the fire lanes established by it are not pre-set. It is evident that in a signal system, such as New Haven's, with over a hundred and ninety installations and radial type street pattern, it would be ex-

tremely difficult, if not impossible, to establish pre-set fire lanes which could serve in even most instances.

Still further, this installation in no way interferes with normal operation of signal equipment. The standard signal controller is not stopped or interfered with in any way. As a result, as soon as the emergency vehicle has passed, the signal system is back to its normal status.

Installation and Maintenance

The installation of this protection equipment also proved to be a relatively simple task, at least for a city such as New Haven, which has a fully developed traffic signal maintenance division and communications division. Transmitters were installed by the same personnel who maintain the transmitters for the regular fire system. Receivers were installed by the men who maintain the traffic signal system. It was found that the transmitters could be installed in two or three hours, and a receiver in approximately one-half day.

Transmitters require virtually no maintenance other than regular inspections for frequency as required by the F.C.C. licensing. With the receivers it proved desirable to set up a routine check system in which the men responsible for maintaining the receivers activated them with their own testing transmitter and made such corrections as were necessary. The device has adjustments for setting distance at which a receiver will respond to the transmitter.

It has been necessary to check this distance and adjust it from time to time. The electronic tubes contained in the receiver require what may be considered a normal replacement rate. In order to be sure that these maintenance procedures were fully absorbed and handled properly, the city did not go forward with its second stage immediately after the first stage. Instead, a full year of experience in operation of the first stage was gained before plans to continue were formulated.

Accident Prevention

It is, of course, most difficult to determine quantitatively what accidents have been prevented by equipment of this nature. Only several years of continuous operation will truly reveal its full effectiveness. The accident history of the New Haven fire department

since 1946 was investigated to see whether any pattern could be detected. It was found that the number of accidents per year varied considerably. In the ten year period prior to installation, there were six accidents at intersections which are not as yet protected. Since the 1956 installation of equipment there have been four accidents, all at locations which did not have this equipment. In addition, there was one accident at a location which does have the equipment, but at the time the signal was not in operation and the intersection was under manual control.

During the one-year period since installation of the emergency equipment, fire department vehicles made 2,800 emergency runs. In the course of these runs, vehicles crossed protected intersections 4,107 times and unprotected intersections 7,064 times.

It is apparent from this record that the actual number of accidents has not as yet been reduced. However, the fact that none of this year's accidents occurred at the protected intersections gives rise to the belief that as more intersections are added to the system the value of such protection will be shown.

As a sample of the protection provided by this equipment there are shown the travel routes of fire department equipment on a tragic day in January 1957, when the worst fire in the city's history occurred (Figure 2). On that day, a large industrial plant went up in flames with a loss of fifteen persons. All fire equipment in the city of New Haven responded either directly to the fire or was moved to standby locations in other critical areas.

As is seen from the sketch, fire equipment passed through eight controlled intersections in response to that single fire. When one considers the great pressure and concentration in the minds of the entire fire department on that day, one must conclude that perhaps in some small measure, our emergency equipment protection prevented one or several accidents that could have happened.

Costs

Thus far, in its emergency vehicle program the City of New Haven has expended $25,000 for equipment, plus about $2,000 for spare parts and testing devices. According to plans, full completion will cost the city a total of about $90,000. It is estimated that at that

time the system would require a full-time maintenance man. Utility costs are negligible. Total operating costs on a year-to-year basis for the entire system are estimated at $6,000. The combined value of police and fire vehicles and apparatus is about one and a half million dollars. If we consider the protection equipment to have a useful life of fifteen years the total program will be costing approximately $6,000 a year for operation, and $6,000 a year for maintenance and amortization.

Thus, we will be spending approximately $12,000 annually to protect a one and a half million dollar investment. Added to this is the inestimable value of human lives protected. Almost any fire apparatus which could be lost in just one accident is worth at least twice this annual cost. The police and fire departments spend thousands annually maintaining their equipment. It must be evident that the price we are paying to protect it, is small.

The Massachusetts Turnpike

WILLIAM F. CALLAHAN

Mr. Callahan was formerly Commissioner of the Massachusetts Department of Public Works, from 1933 to 1939 and from 1949 to 1953. He resigned from that position to become Chairman of the Massachusetts Turnpike Authority. He has spent his building and engineering career in either marine or highway projects, as a company owner of a successful firm engaged in marine railway, dock and dredging work; and as one of the foremost advocates and builders of express highways of advanced design. Mr. Callahan is a member of several local, state, regional and national organizations devoted to the cause of highway construction.

ACROSS the nation millions of cars and trucks travel billions of miles on an interstate toll-road system, including the new 123-mile Massachusetts Turnpike, completed and opened for traffic on May 15th, 1957. The story of the Massachusetts tollway contains all of the complexities of a $239-million project.

The road's beginning cannot be clearly marked by a certain date after a definite statement, remark or event. A previous study of a recommended toll facility from Route 15, at the Connecticut line to Route 1, in the vicinity of Newburyport was rejected by a committee because of insufficiencies in traffic volume.

At the request of the legislature, a second toll road was studied and, on February 12, 1952, a report was submitted. The report's summary and conclusions are part of the following quotation:

"A. The present east-west interstate highway between the metropolitan area of Boston and the New York state line in Hancock is obsolete, inadequate, deficient, and outmoded from a standpoint of traffic safety, efficiency, public convenience and modern engineering standards.

"This highly important route which is vital to the highway transportation needs of the state and nation has been overtaken by rapid functional obsolescence. This is evidenced by the inability of the present facility to handle efficiently the demands of large volumes of traffic including large fleets of heavy commercial vehicles.

"Accidents constantly plague this route and congestion and delays are commonplace. Inadequate widths of roadway, steep grades, sharp curves, insufficient sight distances, numerous cross streets and driveways, frequent traffic signals, numerous crossovers, and lack of suitable divi-

sional areas have contributed to deteriorating this route to its present outmoded condition.

"The Worcester Turnpike, Route 9, has assumed the character of a congested city street and has lost all semblance to a modern through-highway, due in no small measure to roadside encroachment. Route 20 from the Turnpike to the state line is utterly lacking in basic physical dimensions and standards, and also suffers from roadside encroachment.

"Local traffic using sections of this highway should be afforded relief from the hazards and congestion now encountered due to being mixed with through- and other long-distance traffic.

"B. To accommodate and separate properly the large fleets of heavy trucks traveling interstate on this route, as well as the large volume of long-distance passenger movement, it is vital that a modern, east-west highway be provided across the entire state. This highway should be of multi-lane, limited access type, as previously described, completely insulated from roadside encroachment and cross-traffic movement. Widening of the present facilities would result in staggering right-of-way costs, and relocation of the entire route on a new right-of-way is essential.

"All sections and population groups of the state would share in the many benefits of such a superhighway. Moreover, such a highway would be a connecting link in the great integrated interstate toll road express highway system already built or in the process of building in Maine, New Hampshire, Connecticut, New York, New Jersey, Pennsylvania, Indiana, and Ohio – superhighways of defense, commerce, recreation and industry.

"C. To provide this expressway in its entirety as soon as possible cannot be accomplished under current revenues. The revenues available or in prospect are already earmarked or allotted for other urgent highway needs. Toll roads have demonstrated the appropriateness of bond financing for controlled access facilities. Bond financing provides the answer in many areas to the need and demand for relief of congestion now, rather than many years in the future. Prospective tolls secure the funds for construction and a way is found to do the job and do it quickly.

"D. The character of the traffic that would use this facility is the type which has favored the pay-as-you-go policy: paying toll for a facility where ease of travel and savings in operating costs are certain, because of travel time saved and economic savings in gasoline, wear on tires, brakes, etc.

"The road users have expressed a decided willingness to use and pay tolls in Massachusetts for a facility of the type proposed, as indicated in a survey conducted in 1949 for a previous toll road study. The interview form contained the question, 'Would you use a toll road?' Out of the 34,510 persons who answered this question, 29,150 or 84.5 percent, said 'yes.'

"The anticipated reduction in strains, hazards and inconveniences of driving over inadequate and congested facilities has an economic value that is demonstrated here by the willingness of highway users to pay for such relief. Such a highway would attract many thousands of additional travelers to our state every year because our metropolitan centers and recreational, commercial and industrial areas would be several hours nearer to these visitors by way of the high-speed, yet safe, expressway which would be provided.

"E. From reliable basic data of the traffic division of the Department of Public Works, including origin and destination surveys over a period of several years, it is estimated that an average daily volume of 12,756 vehicles would use such a facility during its first year of operation. The number of commercial vehicles would be approximately twenty-five percent of this traffic. It appears that the heavy-duty, semi-trailer type would constitute almost seventy percent of the truck traffic."

The Turnpike's Authorization

A bill was filed in the General Court and the Act became Chapter 354 of the General Laws of the Commonwealth. The Massachusetts Turnpike Authority was created to construct, maintain, repair and operate on such location, as may be approved by the state Department of Public Works, a toll express highway to be known as the Massachusetts Turnpike. Permission was granted to issue turnpike revenue bonds that would be payable solely from revenue to finance the road. The bonds did not constitute a debt of the Commonwealth and the credit and faith of the state were not pledged. The law did specify that the Authority was a public instrumentality and the construction, maintenance, and operation of the turnpike were held to be an essential governmental function.

A route line was set by statute from the vicinity of Boston to the boundary line of the State of New York. But before the preliminary survey line had been completed, a request for an opinion of the Supreme Judicial Court was requested on certain phases of the new law, including the delegation of powers of eminent domain, the meaning of public way, what constituted a toll express highway and a definition of the word "turnpike."

Parts of this opinion – of interest to anyone concerned with highways – are cited in pertinent paragraphs of their decision:

"It is evident that this is to be no ordinary highway of the kind with

which our history has made us familiar. It is an entirely new type of highway which has made its appearance only in comparatively recent years as a result of many changes in the lives and customs of the people brought about by the introduction and general use of the automobile.

"It will run practically the entire length of the main part of the state. It will doubtless consist of a number of paved lanes properly separated and graded to permit safe operation at high speeds comparable perhaps to the speeds of passenger trains on railroads. It is to be expected that there will be few, if any, grade crossings. There are to be ingress and egress only at designated points, in some instances . . . miles apart. There will be signs, signals, and perhaps safety devices of one kind or another.

"There must be space along the sides of the main portion of the way to afford opportunity for slowing down or stopping or for disabled vehicles without interference with the general flow of traffic. In fact in some respects such a way more nearly resembles a new railroad system crossing the state than it resembles the traditional road leading from one town to another. It differs still more from the ordinary city street. Such a road cannot merely be constructed and opened to the public. It must be operated.

"This involves inspection, supervision, and a constant preparedness to remove obstructions and make necessary repairs. This in turn is likely to involve the use of road machinery, towing vehicles, snow plows, and sanding equipment, which must be kept in readiness and may have to be stored at proper places along the way. For all this, buildings may be required, as well as a reasonable provision for garages where necessary repairs can be made upon the turnpike equipment and to keep the vehicles of travelers in operable condition.

"Likewise, it will be necessary to provide gasoline stations at reasonable intervals. These auxiliary structures bear a relation to the turnpike similar to that which the switch towers, water tanks, roundhouses, and stations bear to a railroad. These structures are part of the railroad, although not part of the track.

"What land is needed for the actual construction of this new type of turnpike and what forms part of it and what is outside of it are matters not to be determined by the same standards as would be applied in the case of the country road of fifty or even twenty-five years ago. This enterprise must be envisioned as a whole in its larger aspects.

"In our opinion not only the worked portion of the roadway, including, of course, bridges, abutments, embankments and approaches, but also the kind of buildings and other structures we have mentioned, and a reasonable amount of land taken or acquired on which to place them are all 'needed for the actual construction' of the highway and are parts of it and will be taken or acquired, for and devoted to a public use; and land taken for such purposes will not be 'more land and property than are needed for the actual construction' of the highway.

"We think therefore that reasonable takings for these purposes may be authorized by the legislature under the powers which it possessed before the amendment to Article 10 and which were not cut down by that amendment. Such takings will not be for resale to private individuals. There is involved nothing in the nature of a real estate development which the amendment was designed both to permit within limits and to regulate. The requirements of the amendment are inapplicable.

"More doubt may exist as to restaurants, but on the whole, in dealing with such a highway as the proposed turnpike, we are inclined to classify them with the services previously mentioned. Undoubtedly many travelers will seek food on their way across the state. It will be a great convenience to them to find it at a place where they can park their vehicles without interfering with traffic and without the necessity of looking for an exit, searching for a restaurant, and then re-entering the turnpike.

"The utility of restaurants in connection with travel is attested by the fact that they have long been a customary feature in railroad stations and are now commonly found at the larger airports. The provision for restaurants may also have some tendency to reduce the amount of stopping along the route and to keep the roadway free of refuse. We think restaurants such as are provided for in the Act are parts of the turnpike, and that a reasonable amount of land taken for them is land 'needed for the actual construction' of the highway and is devoted to a public use.

"It seems that the legislature regarded all these auxiliary structures to which reference has been made as parts of the turnpike, since it included all of them in the definition of turnpike in Section 4 (b) of the Act; and we do not believe that the references to 'sites abutting on the turnpike' in Section 5 (f) and to 'abutting property' in Section 5 (k) were intended to narrow the previous definition. It seems obvious that what was said in Commonwealth v. Morrison, 197 Mass. 199,205, about a lunch cart obstructing the street in Adams Square in Boston has no bearing upon the nature of a restaurant upon this turnpike as a public use of land. See also Motoramp Garage Co. v. Tacoma, 136 Wash. 589.

"In reaching our conclusions we have derived some assistance from the New York cases of Blank v. Browne, 217 App. Div. (N. Y.) 624, Anderson v. Taconic State Park Commission, 262 App. Div. (N. Y.) 892, affirmed, 287 N. Y. 668, and People v. La Frantz, 188 Misc. (N. Y.) 989, dismissed for failure to prosecute appeal, 392 N. Y. 699.

"The provisions in Chapter 5 (f) of the Act for the leasing by the Authority of 'gasoline stations, restaurants and other services' are not unconstitutional. They do not involve the taking or holding of lands for private purposes. Property leased will still be devoted to the public purpose of the turnpike, to which these services are wholly subordinate. 'While land cannot ordinarily be taken by eminent domain for the purpose of renting and sale . . . this principle is inapplicable where, as

here, the property so rented or sold is thereby devoted to a public purpose.'[1]

"Neither do we think that any difficulty arises from the use of the indefinite expressions 'other buildings and facilities which the Authority may deem necessary for the operation of the turnpike' in Chapter 4 (b) of the Act and 'other services' in Chapter 5 (f). We think it clear that these expressions are to be construed in their respective settings and that they refer only to such buildings, facilities and services as are reasonably necessary for the public purposes of the turnpike as described in the Act.

"The power granted in Chapter 5 (k) to take 'abutting property to preserve and protect the turnpike' is not, we think, a grant of power to take more land than is 'needed for the actual construction' of the highway as the words just quoted are used in the amended Article 10 as hereinbefore interpreted. Land really needed to preserve and protect the turnpike is needed for its actual construction within the meaning of Article 10. Doubtless this power to take 'abutting property' would be construed with considerable strictness. It is not a roving commission."

1. Opinion of the Justices, 321 Mass. 766,770. Salisbury Land & Improvement Co. v. Commonwealth, 215 Mass. 371, 377–378. McLean v. Boston, 327 Mass. 118, 121. See Murphy v. Commonwealth, 187 Mass. 361,375; Wright v. Walcott, 238 Mass. 432,438; D. N. Kelley & Son, Inc. v. Selectmen of Fairhaven, 294 Mass. 570, 574–575.

Turnpike Bonds Issued for $239 Million

With a favorable opinion and $500,000 to complete necessary traffic, revenue, construction and operational cost reports for financing purposes, the Authority was activated. In March 1954, a firm of consulting engineers reported on traffic and revenues. Their statements were reviewed by New York consultants. In effect, the report found the traffic of sufficient volume to provide revenue to finance the amortization of bonds.

It was estimated that the first full year of operation (1957) would attract 15,970,000 vehicles and bring $14,510,000 in tolls and $726,000 from concession revenues.

In April 1954, general consultants to the Authority reported on the engineering phases of construction costs and revenue estimates.

Excerpts from the report make interesting quotes:

"The need for an adequate highway running the breadth of the Commonwealth is as unquestioned as that traffic conditions on existing highways are deplorable . . . the construction of an east-west highway capable of sustaining a large volume of traffic at reasonable speeds, at low operating costs, and with safety is an economic necessity. . . .

"A growing industry of the present, one not to be underestimated as a source of revenue and income, is the vacation, or tourist trade. In the Berkshire region, west of the Connecticut River, Massachusetts enjoys a region of great scenic beauty. It is a lamentable fact that, aside from local residents, the beauties of the Berkshires seem to be enjoyed only by the residents of Connecticut and New York, who have ready access to the region. The great majority of the inhabitants of the densely populated eastern portion of the Commonwealth remains ignorant or indifferent to its beauties because of inadequate approaches . . . likewise the Cape Cod area will become available to the west. . . ."

Both engineering groups, the traffic experts and the engineering advisors, recommended the tollway as practical and feasible.

A financing syndicate originally planned a $240,000,000 issue; but it seemed feasible to reduce this to the issue figure of $239,000,000. The bonds were sold with par 100 of issues amounting to $1,000 at an interest rate of 3.30 percent. The bonds were to be amortized in forty years.

A trust agreement, signed with The First National Bank of Boston, became effective May 1, 1954. On May 27, 1954 money was available to start aerial surveys, seismic examination of subsurface conditions, and make borings and soundings.

The budget was roughly approximated within the following range: construction, $152,000,000; for acquisition of state roads, $8,000,000; right-of-way, $9,000,000; engineering, $12,000,000; administration and legal, $1,500,000; contingencies, $25,000,000; interest on bonds, $27,000,000; financing, $7,000,000. This grand total of $241,500,000 was to be offset by earnings from investments of $2,500,000, bringing the total to $239,000,000.

A highway design was finally evolved. It was non-access. There were to be six lanes and a ten-foot shoulder on each outer edge with a wide medial strip from Route 128, Weston to Route 9, Framingham. From there to Route 15, Sturbridge, the road was four lanes, shouldered; but built to accommodate six lanes by providing extra widths for the bridges. From Route 15 to the New York state line the road was designed for four lanes.

The lanes were to be twelve feet wide and the minimum radius of alignment was an absolute 3,000 feet and a desirable 5,000 feet. The maximum upgrade was 3.5 percent, and a few downgrades of no more than four percent. The road is 123.3 miles in length and required 190 bridge structures.

Figure 1. Massachusetts Turnpike: wide medial strip near Westfield.

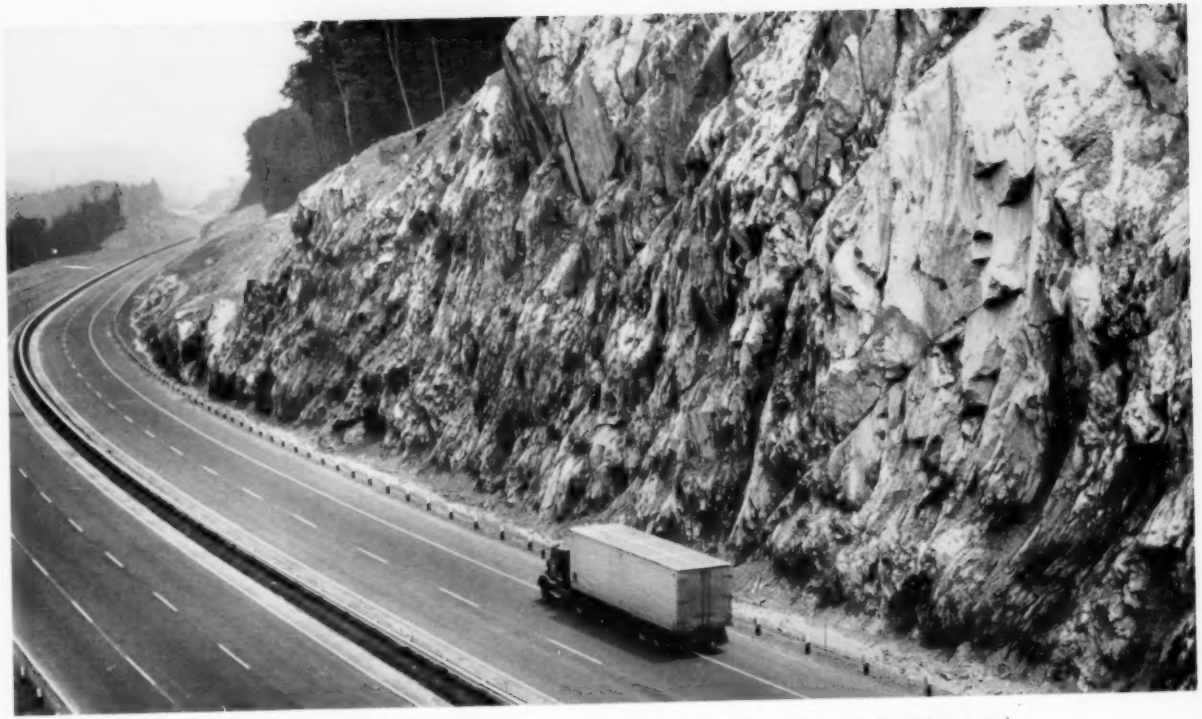


Figure 2. Massachusetts Turnpike through mountains of Russell (looking east).

When the plans were in acceptable form, the Public Works Commissioner went to the people with the proposal. Although the statute does not require it, the Commissioner believed that a public hearing should be held to discuss the plans. Hearings were held in the cities of Pittsfield, Springfield, Worcester and Cambridge; they paid off in sound advice from those who attended.

There is no denying that on many occasions the Public Works Commissioner got solid common-sense suggestions from a local viewpoint that produced a better road and, often, a much better price. In Worcester County the biggest change in alignment was made, saving a lot of money and making many people happy.

There were about 700 other meetings, conferences and public sessions with civic officials, individuals, organizations and associations before the roadway contracts were let. The first contract was awarded and work started in February, 1955.

Problems Loom in Building Turnpike

Problems are part of a New England road building contract. The turnpike presented some that were really formidable – from the mountains of the Berkshires, with a high-point elevation of 1725 feet, to the bogs, marshes, rivers, ponds and lakes to be crossed.

The rivers and glacial ridges and chasms were certainly not in co-operative alignment with our lay-out; rivers that ran north and south, had to be crossed by east-west bridges. The sub-soil conditions varied from the hardest granite to flaky mica hills and soft, crumbly rock formations. Where there was no rock, there were always deep peat beds.

Nineteen contractors with the newest and best equipment handled the thirty-two contracts that were let. Bridges were usually part of a road contract. The turnpike has eighty-three crossings over local roads, six over streams, eleven over railroads; sixty-three roads carry traffic over the tollway, one railroad bridge over the pike, and two turnpike viaducts over rails.

Two major surprises for the turnpike builders occurred in 1955. In August, a hurricane, accompanied by heavy rain, swept the entire state. Communities near the turnpike were hit hard and our contractors pulled heavy equipment off the job to rescue people and

TOTAL QUANTITIES FOR ALL CONTRACTS

Quantities Taken from April 1, 1956 Balance and Excess Sheets

Item	*Quantity*
Clearing and grubbing	4,340 acres
Roadway earth excavation	33,500,000 cubic yards
Class "A" rock excavation	10,800,000 cubic yards
Peat excavation	2,853,000 cubic yards
Ordinary borrow	10,800,000 cubic yards
Gravel borrow	4,260,000 cubic yards
Crushed stone for macadam base	1,700,000 tons
Bitumen for macadam base	10,000,000 gallons
Class 1, bituminous concrete pavement	1,100,000 tons
Steel reinforcement for structures	56,150,000 pounds
Structural steel	92,400,000 pounds
Stock fence	1,287,000 linear feet
Guard rail (cable)	846,000 linear feet
Cement concrete	464,000 cubic yards

restore damaged property. A 200-foot earth fill, part of the new toll road, saved a small town when a dam burst and the rushing waters were held in check by the earth fall.

A gentle, flowing creek, through which men waded, became a roaring torrent and swept a heavy-gauged steel culvert – twelve feet in diameter and 550 feet long – a distance of 1,500 feet, tearing up large trees and boulders and gulping them like a huge reptile.

The job got back to normal and some time was made up before another hurricane and flood hit in October. More rescue work had to be carried out and the poor culvert, newly restored and partially covered with 150 feet of rock and earth fill, was turned into the shape of a colossal doughnut.

Heavy rain fell for weeks. The normal fall of fourteen inches became a flood of more than forty inches. The ground was soaked for the rest of the construction year and then deeply frozen by the worst freezing of many years. The next spring was late and the job got off to a late start.

There were some doubts about completing the project for a November 15th opening in 1956. A cement strike dampened spirits still more and a long steel strike made the scheduled opening impossible. By late fall, it was necessary to concede that the job could not be opened. There were some loose ends that would have been

dangerous for public travel and it was decided to forego the honor of meeting the scheduled date in the interests of public safety.

Toll System Installed

Meanwhile, the service facilities were started. There were toll stations to erect and install, maintenance depots to build, three state police barracks to construct, and men to employ and train as an operational task force.

For practical purposes, nothing is more important than the administrative job of collecting tolls, accounting for them, and expending them wisely in the execution of a contract that is a trust agreement between the Turnpike Authority and its bondholders.

A system was set up to facilitate efficient auditing of toll revenues and to provide a basis for analytical reports on all phases of operation. This system had to allow traffic to move quickly and freely at all times. Known methods of fraudulent practices were eliminated. Some 700 ways to defraud an operating authority are known.

Personnel were carefully selected. Honesty of course was paramount; yet other traits – courtesy, neatness and diligence – were needed. Those who "freeze" or get nastily impatient, when a rush tests the operational procedure, either leave for health and sanity or are asked to resign.

There are daily pick-ups of cash at each change of working shift and a constant machine-audit of traffic. The toll collectors cash in at the end of each shift and there is a daily accounting of the activities of each man on duty to audit overages and shortages.

Once each month a complete summary of revenue and expenses; the number of vehicles in each class using the toll road; all deposits to the credit of and withdrawals from each fund and account; the details of all bonds issued, paid, purchased or redeemed; and a complete balance sheet summarize all transactions for the month.

During the month of January each year an independent firm of accountants makes a full audit of the books of the Authority.

The trust agreement describes the modus operandi of the Authority from a permissive clause to build the toll road, the issuance of contracts with the approval of the consulting engineer and delivery of notice of completion of construction.

Thereafter follow covenants to establish and enforce reasonable rules and regulations governing use of the facility and to operate it with reasonable budget and personnel necessary to operate it efficiently and economically.

The trust agreement is inclusive: every phase of the project, from financing to final amortization of the bond issue, is provided for in detail.

Incidental factors of administration – policing, maintenance and fire control – have special features not ordinarily encountered in the control of state or local highways. Limited access required extraordinary provisions for policing. To handle this phase, a section of the enabling act permitting the employment of state police was invoked. Troopers are employed under the terms of a contract between the Commonwealth and the Authority. This calls for the assignment of the men to the toll facility and the payment of all expenses by the Authority.

Maintenance requires a separate force of servicemen, adequately equipped to keep the road clean, safe, in good repair, and free of snow. Fire-fighting will be at the control level of fire prevention. Small fires can be handled by maintenance and police forces, while assistance will have to be given by local fire departments to handle all other types.

Generally, the procedure followed by this Authority closely resembles the procedure used by governmental agencies with signed vouchers and invoices being extensively used for the transmittal of bills to be paid. Practically all official acts require subordinate signatures and proof of claims to be forwarded through regular channels to the chief engineer, thence to the full board for authorization and payment. All board actions require the approval of the consulting engineer.

On May 15th, 1957, an official opening was followed by an inspection tour by the public. The regular opening came the following day. From the fourteen interchanges, traffic flowed east and west and after the preview was over, the public was as proud as we were of the new Massachusetts Turnpike.

Rivers and ponds and lakes that were our formidable construction foes became our strongest assets of beauty and attractiveness. High hills of ledge became beautiful walls of native granite, through

which the drivers sped, a mile-a-minute. These lofty hills opened a vista of wonderful New England scenery.

Bay Staters, who love to go for a ride spent days exploring the newly opened countryside. Cape Cod reported its biggest dollar volume in history and the Berkshire Hills toppled records for new business. Lexington and Concord never saw such crowds before and they gave credit to the Massachusetts Turnpike.

The Eastern States Fair in West Springfield advertised around the turnpike and had 50,000 more people than ever before and its first 505,000 attendance. A little fair in Great Barrington put $3,125,000 through its pari-mutuel windows in seven days, turning many eager eyes toward the country fairs.

New businesses have been created and plant sites are found near the turnpike. There is a 1,500-acre industrial park in Sturbridge, in Central Massachusetts, and another in Chicopee and a third in the recently industrialized Natick-Framingham area.

There are operational problems of lost tickets, failure to heed or see signs and traffic problems. Tire failure is the chief accident cause and drivers falling asleep accounted for five of eight lives lost.

The turnpike's safety record is consistent with those of other low-average toll facilities and, more important, cities and towns contiguous to the turnpike are reporting fewer accidents, fewer injuries, and fewer fatalities.

The strongest argument for a cross-state turnpike was improving the safety of those who travel the roads – a goal already achieved.

Lesser reasons for its creation are realized. The turnpike will meet its financing obligations, provide new locations for business and industry, and a better way of life for the people of Massachusetts and those who come to visit with us.

How Road-Users Appraise Roads

MATTHEW C. SIELSKI

Mr. Sielski has been Director of the Safety and Traffic Engineering Department of the Chicago Motor Club since 1942. From 1939 to 1942, he was Traffic Engineer for the Chicago Motor Club, directing traffic and transportation studies for cities in Illinois and Indiana. He is a member of the Highway Research Board; director of the Illinois Highway Users Conference; chairman of the Traffic Section of the National Safety Council; vice-president of the Institute of Traffic Engineers, and member of the Western Society of Engineers.

THERE are grave doubts that the national highway program will be successful if engineers limit their attention to the scientific phases of highway construction and ignore desires of motorists. It was by no accident that the recent highway bill was passed. It resulted from enthusiastic support from the motoring public who were willing to have their highway taxes increased if better roads would be built.

Except for motorists protected by such organizations as automobile clubs, the average driver has inadequate representation. His skill has been the target for much abuse; he has been accused of being the sole cause of many accidents, and has been called a moron, and an unscrupulous killer. One critic charged: "Our modern traffic brawl is the greatest mass demonstration of gutter manners ever seen in this country."

Highway planners should remember it was the early highway user who struggled for years to free our civilization from the mire of unpaved roads. Through his efforts and vigorous campaigning we were able to construct suitable roads. In those days the driver had much to say about the types of road desired, where roads were to go, and how available funds should be spent.

Today he finds that little study is made regarding his desires despite the fact that he pays twenty-eight cents of every automobile dollar for taxes. To this twenty-eight cents, add the new federal tax as provided in the highway bill. Clearly, the highway program is no longer a federal-aid project as it was before 1956. The entire cost of financing projects both on the interstate and regular federal-aid

VIEWPOINTS OF 3032 MOTORISTS ON SELECTED TOPICS CONCERNING THE ROAD

Inquiry Topic (Abbreviated wording)	*Number Rated as Serious (or Very Serious)*	*Percent Rated as Serious (or Very Serious)*	*Number Rated as Minor*	*No Reply*
Congestion in the hearts of cities	2664	87.9	173	195
Too many roads unsuited for today's traffic	2586	85.3	244	202
Too few rural divided highways, freeways, expressways	2554	84.2	265	213
*Too few and too expensive offstreet parking facilities	2018	82.8	269	151
Too little and too slow development of expressways in cities	2507	82.7	269	256
Waste and misuse of road tax money	2027	66.9	530	475
Failure to get best use from existing streets	1916	63.2	658	458
Not enough control over roadsides	1382	45.6	1083	567
Too many outdoor advertising billboards	1179	38.9	1499	354

* On this question, 2438 replies were received. The difference between 2438 and 3032 resulted from the change in wording for main group of printed inquiry sheets.

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system is now borne 100 percent by the highway user. It is misleading to quote "ninety percent of interstate paid by the federal government."

In view of the financial stake the motorist has in this program, it seems logical that his needs be given the fullest consideration.

Some Ideas of the Motorist

The following report is one result of the 1953 canvass by the American Automobile Association to obtain the views of 3,032 motorists on selected topics concerning their interests and desires.

Prior to the 1953 report, a sampling was made in twenty states to obtain motorists' general viewpoints. Here are the highlights of that study:

1. *Billboards*: Practically all motorists voting (over ninety percent) favor restrictions against advertising signs on rural roads. The largest number (sixty-six percent) desire sharp restrictions on most sections of rural roads with some provision for advertising signs in areas designated or zoned as commercial. Four percent favored either doing nothing about advertising signs (one percent) or permitting them wherever advertisers want them and property owners are willing that they be placed (three percent).

One out of four (twenty-six percent) favored restrictions only in relatively few places – highly scenic areas or near intersections.

Four percent had special and quite varying viewpoints.

2. *Divided highways:* For heavy main traffic arteries, among eleven listed items, the following were those preferred – voters were reminded that they would have to share in paying for such items:

(a) Divided highways was the outstanding top preference; (b) Controlled access, with express lanes, was second preference; (c) Grade separations at all major traffic intersections received third rating; (d) At least ten-foot wide stabilized shoulders and at least twelve-foot wide express lanes rated next in order.

Other Needs Stated

The need for further education, demonstration, and an emphasis on roadside features was indicated. While in answering other ques-

tions, motorists stated a preference for wide rights-of-way, well-planned attractive roadsides, and scenic turnouts and rest areas, these items were less favored than the items previously listed, and were less favored than long-sight distances, acceleration and deceleration lanes. Local service roads were also low in preference.

One way to appraise these preferences is that these "average motorists" tended rather naturally to give high rating to those features which they can most readily see as directly aiding expeditious and safe travel. Thus, "wide rights-of-way free from pole lines and commercial structures" are understood by highway students to be of fundamental importance – the average motorist more readily sees the advantage to him of, for example, divided highways.

3. *Inadequacies of road signs*: Three out of four motorists voting (seventy-six percent) stated that route number signs in cities cannot be seen well enough at night, while one-half of the voters (forty-seven percent) considered that such signs were too small anyway. Three out of five (fifty-six percent) stated that there were too few route number signs in cities, but about the right number in rural areas (sixty-one percent). However, two out of five (thirty-eight percent) thought there were too few in rural areas. More than half (fifty-four percent) considered route number signs in rural areas too difficult to see at night. Two out of three (sixty-six percent) thought warning and direction signs of about the right size, but half (fifty percent) wanted better night visibility.

Road shoulders: Almost all motorists (ninety-eight percent) consider ample shoulders of considerable or great importance – with two-thirds (sixty-three percent) voting them of great importance. These figures are especially important because again those polled were reminded that good shoulders cost money and they help to pay for them.

Wide rights-of-way: Three out of four motorists want their state to obtain "fairly wide" (forty-four percent) or "quite wide" (thirty-one percent) rights-of-way. Those voting were reminded that their road taxes help to pay for rights-of-way. One out of four suggested that wider rights-of-way be obtained where it seems certain that the need for added travel lanes can be clearly foreseen.

Roadside planting: Five out of six motorists (eighty-three percent) expect their state to do either a modest or considerable amount of

roadside planting. Two out of three favored a modest amount. Voters were reminded that the cost of such planting comes in part from their road tax.

Roadside scenic turnouts and rest areas: Five out of six motorists (eighty-five percent) considered roadside scenic turnouts and rest areas a good or very good idea. Almost one out of two (forty-four percent) considered these a very good idea – there should be more of them, well maintained; three percent considered roadside areas a waste of tax money.

Practically all motorists voting (ninety-seven percent) were familiar with roadside scenic turnouts and rest areas, and three out of four (seventy-four percent) had used them.

Protected parking in roadside areas: Among items that may be provided in such roadside areas, the top vote was for "parking space physically separated from travel lanes." Next in preference was toilets, then picnic tables and containers for rubbish. Benches and fireplaces practically tied for next choice; drinking water was last.

Experience often shows that such roadside areas become untidy. More education and emphasis on cleaning up after use is called for.

Changing views: Large changes are occurring in the attitude of the motoring public toward what they want in and alongside their highways. Two out of five rated these changes in attitude as "considerable," while an equal number rated them as "great." Only one out of five stated that no changes (one percent) or few changes (eighteen percent) were occurring. This is an encouraging indication of progressiveness among motorists.

The quoted statistics were based upon the viewpoints of "average motorists," not highway transportation specialists. While the sample is small, it is widely distributed. Voters in general were persons calling at AAA Clubs for touring information.

Motorists reported driving a wide range of miles a year. One-third (thirty-five percent) estimated their annual mileage as 10,000 miles. One out of five (nineteen percent) gave 15,000 miles, while one out of six (fifteen percent) gave 5,000 to 9,000 miles. Thus, seven out of ten (seventy percent) drove from 5,000 to 15,000 miles a year. Eight percent drove over 25,000 miles a year (one percent – 60,000 miles) and eight percent drove 4,000 miles or less.

On the basis of this survey, an examination of the motorist's

desires may serve to determine what might be done to meet the expectations of the driver:

Divided Highways: The average motorist likes to take to the road in comfort, safety and in a mood of relaxation. He dreads situations that "challenge" him, such as passing maneuvers, strain of oncoming cars, fast stops and slow-moving vehicles. This is particularly true at night when additional hazards are created by less sight-distance and the glare of oncoming cars. Divided highways relieve him of much of this pressure, and he experiences greater freedom in the operation of his car. He can choose his range of speed, and travel with more safety with less strain or conflict. This gives him more motoring enjoyment and relaxation, which is one of the secrets of success of the toll roads.

Inadequacy of Road Signs: Many of today's motorists take long distance trips. The inadequacy of proper and uniform directional signs is apparent to them in many areas. Highway engineers apparently assume that motorists are familiar with local situations and conditions. Engineers appear either to ignore markings completely or use signs and nomenclature that are known to local residents only.

Many highway departments indicate turn-off on important routes with such instructions as: "Bryn Mawr Avenue Exit Ahead" or "Twenty-Ninth Street Exit." To the out-of-town motorist, such signs mean nothing. In other instances, references are made to the next city or town. Unless the numerical highway route is indicated by such signs, the motorist becomes confused, lost and irritated.

Improper signs are also a frequent complaint of motorists who have been arrested for alleged traffic violations. The complaint is often made that signs warning, regulating or directing traffic are not clearly visible or are not readily understood. This comment is most often made with respect to highways with two or more lanes of traffic moving in both directions. When traffic is heavy, signs on the right edge of the highway are invisible to drivers in the inner lane, and signs mounted on standards in the center of the highway are difficult to see from the outer lane.

Road signs, markings, and symbols of all kinds must be clear, concise and simple. We are dealing with a motoring public of varied educational background and limited traveling experience.

Downtown Congestion: Perhaps the greatest complaint raised by motorists is congestion in cities. They are invariably irritated by delays caused by left turns, double parking, improper signs, heavy traffic, railroad crossings, and others. Often among their criticisms are the situations involving expensive construction of traffic facilities which, because of improper design, cause congestion elsewhere along the route.

An example was the recent completion of a grade separation over a railroad pass in the Chicago area. This had been a point of much congestion until the new bridge was constructed. Unfortunately, traffic planners did not take into consideration that the widening of the bridge facilitated its use by a greater number of vehicles. No provision was made for the proper handling of the traffic as it reached an intersection just beyond the bridge. As a result, congestion still exists on a very expensive facility because of inadequate planning. The motorist sees no great improvement despite the fact that large sums were spent in building this structure.

Highway planners should take cognizance of the value of economic savings through construction of properly planned facilities.

Economic Values

In examining the economic value of the superhighway program in Chicago, a study was made of 100 miles of surface streets and a similar number of miles on the west side expressway. On the basis of this study, the total annual savings to motorists using the contemplated network of expressways in Chicago will be $30,000,000 or $71 a vehicle. The savings in gasoline alone amounts to $14,770,000 or $35 a vehicle.

In their desire to construct expressways in cities, traffic planners often ignore the need for good major arterial systems to get the vehicles to and from these expressways. Because of these oversights, delays continue to exist on major arteries. For example, many important routes are cut off by expressways, the assumption being that the modern thoroughfare will carry most of the local traffic. Often this is not true, specifically in the instance of the expressway program in Chicago. When this network of fifty-three miles of expressways is completed, it will carry only one-half of the city's traffic. The other half will be traveling over surface streets.

Thus traffic engineers must continue to consider such measures as signal co-ordination, left turn lanes, development of good major arterial streets, pedestrian control, limited grade separations, one-way streets, reversible lanes. And while we are on this subject, the average motorist is not interested in what agency provides him with the necessary roads – he is interested in traveling from his origin to his destination in the fastest time possible.

An example of the extent to which a motorist will go to use a modern facility is found on a portion of the west side expressway in Chicago that starts from nowhere and goes nowhere. It is approximately two and a half miles long and will eventually connect with the present expressway in Chicago, but in the meantime, it doesn't serve any specific purpose. Despite this, however, it still carries 25,000 vehicles a day.

User Attitude: Highway planners can take a page from the toll roads' success story. Despite the tremendous cost of these roads the motorist is using them frequently. Does he use these facilities because of their economy or safety values? The answer is an emphatic "No." Generally speaking, the average motorist is not economy-minded when it comes to travel. When the average layman buys a car, he doesn't look for economy or efficiency. He is more interested in comfort, prestige, and beauty. The extras he pays for – power steering, power brakes, more horsepower, power windows – all measure his desire for personal satisfaction. And so it is with roads. The turnpike gives him everything he has hoped for in a highway.

Not economy but beauty, comfort, convenience, pleasure, and time-saving. For this he is willing to pay an extra fare despite the fact that in most states he pays approximately $1.60 for gas taxes each time he fills his tank full of gasoline. In a toll road he knows what he is getting when he pays for it, but this is not his attitude when it comes to public highways.

He is suspicious about the disbursement of highway funds. He is, therefore, very reluctant to pay for much-needed highway improvements unless he is convinced that they are necessary. Obviously, highway planners must reckon with this popular motorist viewpoint and must combat it through a sound and sensible public relations program. Mr. Motorist should be told of the highway department's plans, how much roads cost, how much will be required for maintenance, police and all the other things that are

necessary in order to carry out a highway program. The time has come when highway planners must improve roads carrying the major traffic, and spend less for "political" roads. So long as the motorist pays for good roads, let's build them.

Roadside and Roadway Gripes

On the subject of billboards, the average motorist is not as concerned about the presence of these as he is in the improper use of them. It is quite distasteful to him to view a highway cluttered with all types of signs. Many present hazards because of their proximity to intersections and their competition with signs and signals.

He is for signs that serve a purpose, such as indications of sleeping and eating accommodations, service facilities and points of interest. Billboards tend to help him pass his time away by directing his mind momentarily from monotonous driving. The answer to this issue may be in the establishment of a uniform code for signs in regard to size, shape and location.

In regard to services, the motorist is completely opposed to being detoured into business districts. He is interested in finding his services at convenient places along the route where he can appraise them quickly and without undue loss of time. Much has been said about the provision of gas facilities on the interstate highway network and its effect upon business now established off the system. In making decisions, highway engineers should consider the motorist's desires, not loss of business to those affected by a new road.

The motorist also desires freedom in choice of rest stops. Many are looking for convenient rest areas. At such places, they find complete relaxation in stopping for a picnic lunch, a chance to rest, and a place for children or pets to "run off some steam." This is highly important because of the development of the interstate system. There will be a great danger resulting from drowsiness on such thoroughfares. The writer has recently studied this problem and made the following conclusions based upon approximately 1,000 miles of turnpike travel:

1. It is drowsiness and not fatigue that presents a danger on the modern expressway. With many automobiles now equipped with power steering and other conveniences, it is possible to travel many

miles without muscular weakness. The important factor, however, is weariness due to long miles of monotonous driving.

2. Traveling from Chicago to New York without interference is a new experience that awaits all motorists. For the first two hundred miles, travel is without pain. Beyond this point, however, danger lurks in the form of hypnosis. There isn't enough diversion to break this monotonous driving. Therefore, the following procedure is recommended: (a) Make a stop after the first three hours of travel; (b) Make a stop every 100 miles thereafter; (c) Don't travel more than 450 miles in one day.

3. Highway designers need to give more attention to the planning of expressways so as to relieve highway hypnosis. New York Thruway engineers have done an excellent job in this respect. Center dividers are frequently changed to varying widths. Sometimes a few trees will appear while in other areas the center will contain large rocks or rivers. Villages are planted in picturesque style to attract the eyes of the long distance traveler. This is not common on other turnpikes traveled on this trip.

4. Even with changing of drivers, the dangers of drowsiness are present. This is an important point to remember for those who feel that long distances should be covered by two or more drivers.

5. With the prospects of many more miles of such expressways to be built as a result of the present highway program, more research is necessary to determine driver behavior on these modern routes. Educational programs are needed to inform motorists of the perils of expressway travel.

Driver Hypnosis

On the basis of these studies, it was determined that the drowsiness and not muscular fatigue caused a dangerous situation. It was apparent that highway planners must design highways that will relieve monotonous situations caused by mile after mile of tiresomely uniform parallel highways. The New York Thruway has taken precautions by relieving monotony through well-designed landscaping.

As Federal Highway Administrator B. D. Tallamy puts it, "Monotony, driver hypnosis, inattention – whatever you call it –

will continue to pile up accident statistics if controlled access highways are built like two parallel railroad tracks." Therefore, in order to satisfy the desires of the motorist, modern highways must provide for well-planned service facilities.

The highway user who pays a good portion of his automobile dollar for taxes wants good roads. In the words of the late Thomas H. McDonald, "We pay for good roads whether we have them or not – and we pay *less* if we have them than if we do not." Highway planners would do well to take cognizance of some of the major shortcomings pointed out in this report. Experience has shown that the motorists will pay for something he thinks is necessary.

Good public relations must become an important aspect of highway construction. While proper designs and economical factors are necessarily fundamental to good highway construction, they fail to attain their goal if human traits and desires are not satisfied. The customer is waiting to pay for his purchase. Let's not lose him by selling an inferior product.

Urban Highway Construction And Its Regional Effects

GEORGE W. BURPEE AND JAMES L. RAY

Mr. Burpee is a partner in the firm of Coverdale and Colpitts, Consulting Engineers, of New York, with whom he has been associated for thirty-six years. He has devoted a great deal of attention to highway transportation and the financing of bridges, tunnels and turnpikes by the sale of public revenue bonds. His firm made a report for the first facility of this kind, the Louisville Bridge, financed by toll revenues. Mr. Burpee is a director of several corporations, a past president of the American Institute of Consulting Engineers and a past vice president of the American Society of Civil Engineers.

Mr. Ray has been associated with the firm of Coverdale and Colpitts since 1953. Prior to that time he had had considerable experience in highway planning and traffic. In his present position, he has been engaged in a wide variety of traffic projects, including New York area studies involving traffic movements across the Hudson River, along the Garden State Parkway and New Jersey Turnpike and their extensions to the New York State line. Mr. Ray is a member of the Institute of Traffic Engineers and holds a certificate from the Yale Bureau of Highway Traffic.

THE urban areas of the United States are entering a period of highway construction without precedent. More and more new highway facilities are being provided to accommodate the rapidly increasing volumes of vehicles and their growing use. This article will discuss the increasing complexity of urban highway planning and construction and will set forth some of the effects that new urban highway construction may be expected to have upon traffic along adjacent roads and upon land development of surrounding areas. It will also discuss some of the ways in which adequate regional planning and control can help us to obtain a fuller value for each new highway facility provided.

In this country, vehicular traffic enjoys almost complete freedom from political or geographic barriers. Instead, it is limited only by the physical capacities of existing highways and by desires of indi-

vidual motorists. When the desires of motorists exceed the capacities of existing facilities, it becomes necessary to provide additional roads and streets. We are now in a period where the demand for urban express highways greatly exceeds the available supply and many separate facilities must be constructed to bring the supply-demand ratio into reasonable balance.

The reason for this tremendous excess demand is well known. During the last generation, highway transportation has largely dictated the pattern of development of our urban areas. As motor vehicles have developed, the individual has been released from dependence upon rail and transit facilities, and residential districts have spread beyond and between them.

People must, however, continue to rely to a large degree upon the central city for employment and certain shopping and cultural activities. This situation has resulted in continual shuttling of people and goods between the outer areas and the central business districts during each working day, and between residential districts and the further removed recreational areas on all non-working days.

Since vehicular trips are restrained only by the motorist's desire and the highway's capacity, a single trip may traverse many political boundaries and use highways that are under various governmental jurisdictions. If these various jurisdictions fail to correlate their planning and construction activities, the free flow of vehicles along desired routes is interrupted; congestion and frustration result. In many cases, where local governing bodies have failed – or for one reason or another have been unable – to act together to provide adequate and uniform roads, authorities or commissions have been appointed by the interested local governments to take over the problem and provide the required facilities.

Limitations are normally placed on the powers and scope of work these special agencies may undertake, with the result that, although specific situations may be handled satisfactorily by them, new problems that may arise in their area are frequently out of their jurisdiction. This limitation sometimes results in the creation of still another body which, in turn, must be brought into line with the planning and construction activities of already existing highway agencies.

As any urban area expands into the surrounding countryside,

the problem of providing adequate facilities for the movement of metropolitan traffic becomes further complicated by including more and more suburban municipalities and county and state governments. The degree of complexity which eventually results from this type of development is at its most extreme form in the area surrounding – and affected by – New York City, the largest city in the United States and the busiest traffic area in the world.

New York Metropolitan Area

The New York Metropolitan area, as normally defined, encompasses some 7,000 square miles and includes portions of the states of New York, New Jersey and Connecticut. Within this section, approximately 15,250,000 people – 9.1 percent of the population of the United States – live and work. The area's continuing growth is demonstrated by a rate of population increase from 1950 to 1955 of 9.1 percent, as compared to an 8.6 percent increase for the country as a whole.

Existing forecasts indicate that population increases will continue as development of the immediately surrounding areas takes place. At the present time, the New York Regional Plan Association estimates that approximately 1,100 square miles of the metropolitan area are developed. Approximately 4,000 square miles, suitable for development, remain. More than twenty-two counties and 550 cities and municipalities divide this tri-state metropolitan area into one of the most complex political regions of the world. Each of the subdivisions within the area influences to some extent the highway development that occurs within its local jurisdiction.

The degree to which urban vehicular travel has developed is illustrated by the traffic volumes carried by some of the highway facilities in, or adjacent to, New York City.

An over-all increase of 585 percent has occurred since 1925. This amounts to an annual average increase of 6.4 percent. Operation of two of the facilities, the Holland and Lincoln Tunnels, is now at approximate capacity. The recent opening of a third tube at the Lincoln Tunnel, however, will permit growth at this crossing.

The leveling off of traffic on the George Washington Bridge between 1955 and 1956 is primarily the result of diversions to the

Tappan Zee Bridge of the New York State Thruway. Completion of these diversions, and additional capacity provided by double-decking will result in continuing growth of vehicle volumes on the George Washington Bridge.

WESTERN APPROACHES TO NEW YORK CITY

Year	George Washington Bridge	Lincoln Tunnel	Holland Tunnel	Hudson River Ferries	Tappan Zee Bridge	Total Vehicles	Percent Increase
			(Thousands of Vehicles)				
1925	—	—	—	12,548	—	12,548	—
1930	—	—	12,067	13,708	—	25,775	105%
1935	6,395	—	11,387	12,547	—	30,329	18
1940	8,456	3,913	13,331	13,714	—	39,414	30
1945	8,332	6,513	12,399	5,416	—	32,659	—17
1950	19,870	15,533	18,126	4,796	—	58,324	79
1955	35,775	21,341	20,238	2,176	168	79,697	37
1956	35,523	21,619	20,848	1,689	6,334	86,013	8

Data for other crossings show the rapid growth of local traffic:

Year	Bronx Whitestone Bridge	Brooklyn Battery Tunnel	Cross Bay Parkway Bridge	Henry Hudson Bridge	Total Vehicles	Percent Increase
			(Thousands of Vehicles)			
1940	6,318	—	3,428	12,845	22,591	—
1945	5,166	—	2,505	7,813	15,484	—31%
1950	17,292	8,197	5,344	19,549	50,382	225
1955	27,924	16,733	6,424	26,002	77,083	53
1956	29,834	17,588	6,394	25,428	79,244	3
					Over-all Increase	251
					Annual Average Rate	8.2

Some of the special agencies, other than normal state, county or city departments, now operating or constructing major highways in the New York Metropolitan area, are:

New Jersey Turnpike Authority
New Jersey Highway Authority
Garden State Parkway
Palisades Interstate Park Commission
New York State Thruway
Port of New York Authority
Triborough Bridge and Tunnel Authority

Activities of these agencies must be related to the planning and construction work of many state, county and city groups. Although

a network of roads and streets has been provided by the conventional highway departments, it has been necessary to create these special bodies to aid in providing adequate highway facilities, most of which are supported at least in part by the collection of tolls.

Effects of Highway Construction

The construction of any new highway facility frequently results in drastic changes in traffic movements and in the type and degree of land development within the area the facility traverses. In many cases, the principal purpose of a highway may be to serve traffic passing completely through an area, with no direct benefit to the area itself except relief from congestion on the highways normally serving the area. Harmful results from the roadway's construction may result, in fact, unless local authorities take prompt and adequate action to protect the area involved.

Uncontrolled commercial strip development, with consequent residential area deterioration, and local street congestion are among the most common ills resulting from new construction. A new facility may, on the other hand, permit a needed area redevelopment by providing new means of access. Many desirable and valuable commercial ventures tend to locate next to adequate highway networks, and improved transportation may provide a new economic base for an unstable area. Local planning and control normally dictate whether a new highway facility will aid or hinder optimum area development.

The effect of highway construction upon a small section within a metropolitan region may be seen in a study of the area outlined in Figure 1. This area, bounded roughly by the New York State Thruway on the north, the Hudson River on the east, and New Jersey Routes 4 and 17 on the south and west, includes some fifty-four municipalities. The southern portion of the area lies on the present fringes of the heavy residential developments surrounding New York City. The northern portion of the area is relatively lightly developed and contains little commercial activity.

The map shows that, in addition to strictly local streets and county roads, the following major north-south highways bound or bisect the area:

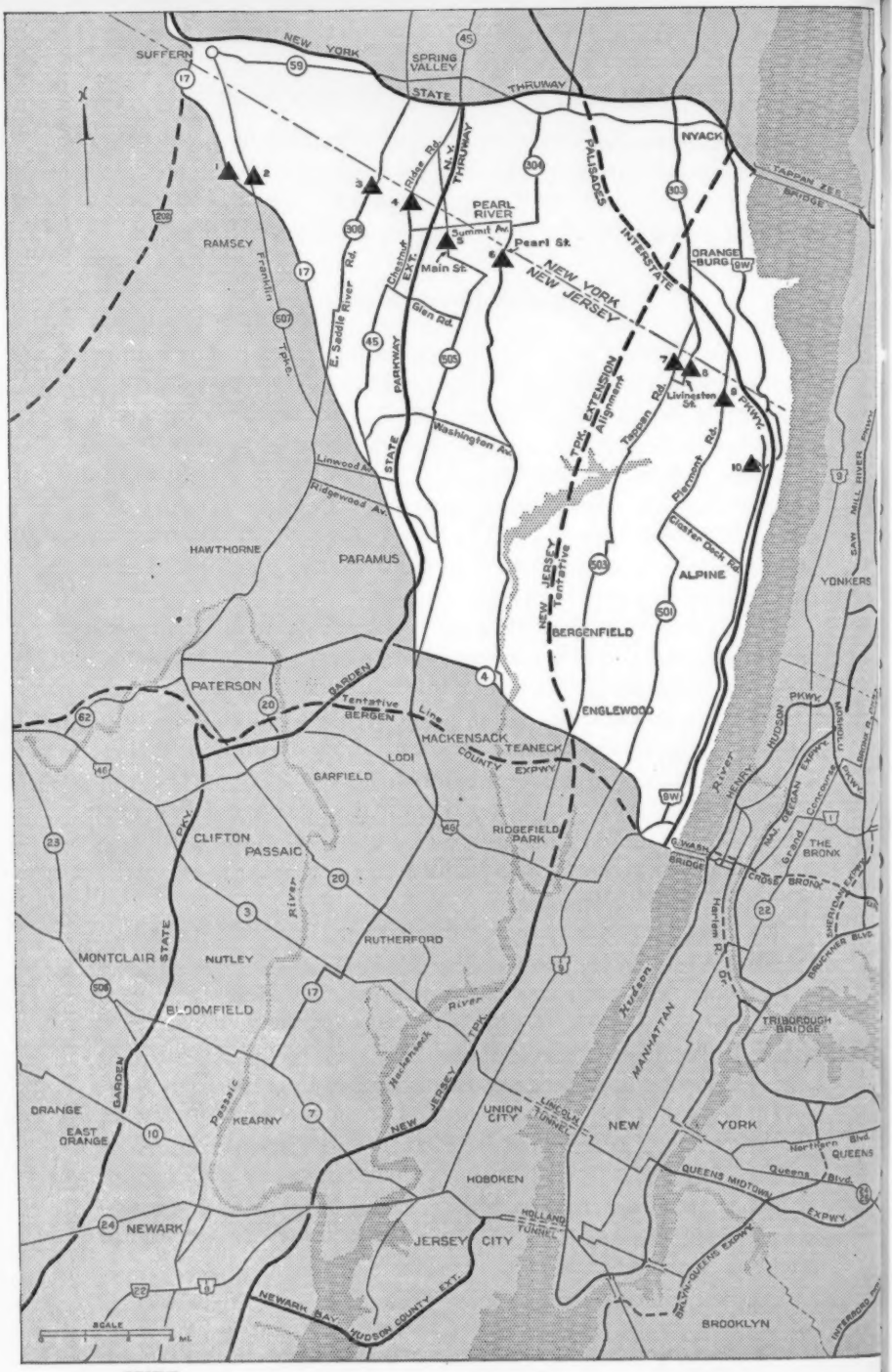
SUFFERN
NEW YORK
SPRING VALLEY
THRUWAY
STATE
NYACK
TAPPAN ZEE BRIDGE
PALISADES INTERSTATE
PEARL RIVER
Summit Av.
Pearl St.
Main St.
Rte. 59
Chestnut Ext.
Glen Rd.
RAMSEY
Franklin Tpke.
E. Saddle River Rd.
PARKWAY
NEW YORK NEW JERSEY
ORANGEBURG
Livingston St.
Piermont Rd.
Cloister Dock Rd.
Washington Av.
Linwood Av.
Ridgewood Av.
TSK EXTENSION Alignment
NEW JERSEY Tentative
HAWTHORNE
PARAMUS
ALPINE
YONKERS
BERGENFIELD
ENGLEWOOD
PATERSON
GARDEN
Tentative BERGEN Line
HACKENSACK
TEANECK
COUNTY EXPWY.
LODI
GARFIELD
RIDGEFIELD PARK
CLIFTON
PASSAIC
RUTHERFORD
NUTLEY
MONTCLAIR
BLOOMFIELD
ORANGE
EAST ORANGE
KEARNY
HOBOKEN
UNION CITY
JERSEY CITY
NEWARK
NEWARK BAY HUDSON COUNTY EXT.
HOLLAND TUNNEL
LINCOLN TUNNEL
MANHATTAN
NEW YORK
THE BRONX
TRIBOROUGH BRIDGE
QUEENS
QUEENS MIDTOWN EXPWY.
BROOKLYN
SCALE
LEGEND:
SURVEY STATIONS
EXISTING ROADS
ROADS PLANNED OR UNDER CONSTRUCTION

Figure 1.

Garden State Parkway-New York State Thruway connection
Palisades Interstate Parkway
New Jersey Route 17
U.S. Route 9W
New York Route 303

Still another facility connecting the New Jersey Turnpike and the New York State Thruway is planned for construction through the region.

Two routes – the Garden State Parkway-New York State Thruway connection and the Palisades Interstate Parkway – are limited-access facilities open to passenger vehicles only. Tolls are charged on the Garden State Parkway. The other routes are, for the most part, dual highways with free access.

Changes in Land Development

Construction of these routes in the study area has had, or is expected to have, varying effects upon the land development adjacent to them. New Jersey Route 17 and U.S. Route 9W have been in existence for some time; New York Route 303 is a relatively new highway. Extensive strip development has taken place along most of New Jersey Route 17 and along the southern portion of U.S. Route 9W. These two facilities serve as main highways for large volumes of travel between New York City and recreational areas in the Catskills. Conflicts between this through-traffic and local movements to and from the commercial establishments along the routes cause heavy congestion during many week-end periods.

The presently incomplete Palisades Interstate Parkway is a new route with a five-mile section between Alpine, New Jersey, and Orangeburg, New York, opened in June, 1957. The final five-mile section between the New York State Thruway and New York Route 303 is scheduled for completion in July, 1958. Since this road is limited to passenger vehicles and is primarily designed to serve through-traffic, it is expected to have little effect upon land use, other than increased residential development near interchanges.

The complete Garden State Parkway-New York State Thruway connection was opened to traffic in August, 1957. Since it provides ready access between relatively open land in the study area and commercial centers in Newark and other points to the south, ex-

tensive residential building is expected in the areas adjacent to it. Prohibition of commercial vehicles on the facility will undoubtedly keep changes of a commercial nature to a minimum.

Although this facility was only recently opened to traffic, comparison of the present area with the area as it was two years ago shows that, during the period of the highway's construction, heavy residential development occurred along the southern portion of the route. As this activity continues, population increases will require additional schools, local roads, and public utilities of all kinds. If serious community problems are to be avoided, careful planning by local authorities must be carried out during the next few years.

Changes in Traffic Movements

As each new facility is provided, the traffic pattern on nearby roads and streets changes. An example of these changes in the study area is available from survey data obtained in June of 1955. At that time, origin and destination survey stations were set up at ten locations on north-south roads within the study area. (See Figure 1.)

These surveys were conducted to determine the amount of traffic that would be attracted to the Garden State Parkway and to the New Jersey Turnpike if these highways were extended from their 1955 northern termini to the New York State Thruway. After expanding the survey data to account for seasonal variations, the following annual 1955 passenger car movements were obtained:

1955 SURVEY STATION DATA – ANNUAL VOLUMES

Station Number	*Location*	*New Jersey passenger cars*	*Percent of total*	*Out-of-state passenger cars*	*Percent of total*	*Total passenger cars through station*
1	New Jersey 17	1,401,296	30.4%	3,202,044	69.6%	4,603,340
2	Franklin Turnpike	971,899	54.8	802,292	45.2	1,774,191
3	E. Saddle River Rod.	329,063	60.2	217,234	39.8	546,297
4	Chestnut Ridge Rd.	286,743	44.1	364,158	55.9	650,901
5	Main Street	432,316	76.9	129,688	23.1	562,004
6	Pearl Street	646,286	49.5	660,403	50.5	1,306,689
7	Tappan Road	252,609	64.9	136,894	35.1	389,503
8	Livingston Street	581,226	64.2	324,589	35.8	905,815
9	Piermont Road	256,104	63.5	146,924	36.5	403,028
10	U.S. 9W	1,025,450	23.7	3,301,589	76.3	4,327,039

Table I

ESTIMATED PASSENGER CAR DIVERS

TO PALISADES INTERSTATE PARKWAY, NEW YORK THRUWAY AND GARDEN S

Station No.	Location	Vehicle Type	1955 Annual Volume	1957 Annual Volume	V		
					New York Thruway		Pa
					Vehicles	Percent	Veh
1	N.J. 17	N.J. Passenger Car	1,401,296	1,555,439	4,060	.3	3
		Other Passenger Car	3,202,044	3,554,269	513,498	14.4	1,13
		Commercial	1,202,737	1,335,038	(1)		(
		Total	5,806,077	6,444,746	517,558	8.0	1,16
2	Franklin Turnpike	N.J. Passenger Car	971,899	1,282,907	—		1
		Other Passenger Car	802,292	1,059,025	63,476	6.0	13
		Commercial	392,212	517,720	—		
		Total	2,166,403	2,859,652	63,476	2.2	15
3	E. Saddle River Road	N.J. Passenger Car	329,063	338,935	791	.2	1
		Other Passenger Car	217,234	223,751	33,811	15.1	2
		Commercial	62,239	64,106	—		
		Total	608,536	626,792	34,602	5.5	3
4	Chestnut Ridge Road	N.J. Passenger Car	286,743	295,345	—		2
		Other Passenger Car	364,158	375,083	8,544	2.3	7
		Commercial	75,828	78,103	—		
		Total	726,729	748,531	8,544	1.1	9
5	Main Street	N.J. Passenger Car	432,316	445,285	—		
		Other Passenger Car	129,688	133,579	—		
		Commercial	55,518	57,184	—		
		Total	617,522	636,048	—		1
6	Pearl Street	N.J. Passenger Car	646,286	665,675	—		2
		Other Passenger Car	660,403	680,215	—		5
		Commercial	176,455	181,749	—		
		Total	1,483,144	1,527,639	—		5
7	Tappan Road	N.J. Passenger Car	252,609	260,187	—		
		Other Passenger Car	136,894	141,001	1,958	1.4	
		Commercial	58,020	59,761	—		
		Total	447,523	460,949	1,958	.4	5
8	Livingston Street	N.J. Passenger Car	581,226	598,663	—		8
		Other Passenger Car	324,589	334,327	6,743	2.0	(
		Commercial	174,149	179,373	—		
		Total	1,079,964	1,112,363	6,743	.6	1
9	Piermont Road	N.J. Passenger Car	256,104	263,787	—		(
		Other Passenger Car	146,924	151,332	6,142	4.1	
		Commercial	33,385	34,387	—		
		Total	436,413	449,506	6,142	1.4	1
10	U.S. 9W	N.J. Passenger Car	1,025,450	1,138,250	—		9
		Other Passenger Car	3,301,589	3,664,764	—		3,5
		Commercial	328,422	364,548	—		
		Total	4,655,461	5,167,562	—		4,4

(1) Due to mileage penalties and toll charges commercial vehicle diversions to New York Thruway negligib
(2) Only passenger vehicles permitted on Palisades and Garden State Parkway.

VERSIONS

EN STATE PARKWAY EXTENSION · 1957 BASE YEAR

Vehicles Diverted					Vehicles Remaining at Original Station	Percent Remaining at Original Station
Palisades Parkway		Garden State Parkway		Total		
Vehicles	Percent	Vehicles	Percent			
34,302	2.2	16,557	1.1	54,919	1,500,520	96.5
1,132,550	31.9	1,002	—	1,647,050	1,907,219	53.7
(2)		(2)		—	1,335,038	100.0
1,166,852	18.1	17,559	.3	1,701,969	4,742,777	73.6
17,093	1.3	38,367	3.0	55,460	1,227,447	95.7
137,380	13.0	36,862	3.4	237,718	821,307	77.6
—		—		—	517,720	100.0
154,473	5.4	75,229	2.7	293,178	2,566,474	89.7
13,616	4.0	56,544	16.7	70,951	267,984	79.1
25,350	11.3	41,840	18.7	101,001	122,750	54.9
—		—		—	64,106	100.0
38,966	6.2	98,384	15.7	171,952	454,840	72.6
20,535	7.0	135,457	45.8	155,992	139,353	47.2
75,286	20.0	161,661	43.1	245,491	129,592	34.6
—		—		—	78,103	100.0
95,821	12.8	297,118	39.7	401,483	347,048	46.4
7,819	1.8	62,741	14.0	70,560	374,725	84.2
3,043	2.3	42,553	31.8	45,596	87,983	65.9
—		—		—	57,184	100.0
10,862	1.7	105,294	16.6	116,156	519,892	81.7
23,417	3.5	102,889	15.5	126,306	539,369	81.0
34,405	5.1	117,220	17.2	151,625	528,590	77.7
—		—		—	181,749	100.0
57,822	3.8	220,109	14.4	277,931	1,249,708	81.8
17,704	6.8	2,480	1.0	20,184	240,003	92.2
19,549	13.9	1,797	1.2	23,304	117,697	83.5
—		—		—	59,761	100.0
37,253	8.1	4,277	.9	43,488	417,461	90.6
86,797	14.5	37,797	6.3	124,594	474,069	79.2
65,298	19.6	28,781	8.6	100,822	233,505	69.8
—		—		—	179,373	100.0
152,095	13.7	66,578	6.0	225,416	886,947	79.7
65,528	24.9	6,691	2.5	72,219	191,568	72.6
36,682	24.2	8,659	5.7	51,483	99,849	66.0
—		—		—	34,387	100.0
102,210	22.7	15,350	3.4	123,702	325,804	72.5
954,059	83.8	184,191	16.2	1,138,250	—	0
3,539,359	96.6	125,405	3.4	3,664,764	—	0
—		—		—	364,548	100.0
4,493,418	86.9	309,596	6.0	4,803,014	364,548	7.1

gligible.

It may be noted from these figures that the two major routes surveyed, N.J. Route 17 and U.S. Route 9W, carried high percentages of out-of-state passenger cars. For the most part, these vehicles were traveling between New York City and areas in northern New York State.

At the time of these surveys the New York State Thruway was still under construction and the Palisades Interstate Parkway was open in the study area only between the George Washington Bridge and Alpine, New Jersey. Since completion or extension of these two major facilities was expected prior to the 1957 estimated opening date of the Garden State Parkway extension, an accurate estimate of probable extension-use required estimates of the traffic flow changes that could be expected to result from completion of the first two facilities. Study of the origins and destinations of existing movements and of trip times, distances, tolls and other factors affecting choice of route, permitted these estimates to be made.

Table 1 presents the estimated 1955 base year diversions to the New York State Thruway and the Palisades Interstate Parkway; and, subsequently, the diversions to the Garden State Parkway extension. These diversions illustrate the effect that new highway building may have upon the volume of vehicles using existing roads.

Construction of the New York State Thruway and the extension of the Palisades Interstate Parkway have affected the study area by diverting heavy volumes of non-New Jersey passenger cars from the main routes, N.J. 17 and U.S. 9W, and lighter volumes from the minor routes. The minor route-trip diversions are motorists who are forced to use local streets because of inadequate capacity on the main highways. Their diversion has resulted in an obvious easing of congestion, particularly during summer week-ends.

Trafficwise, the primary purpose of the Garden State Parkway Extension was to provide a high-speed connection for passenger vehicles moving between the various residential sections of northern New Jersey and the metropolitan areas to the south. In addition, the route serves to relieve N.J. Route 17 during peak periods and will provide a possible by-pass, via the proposed Westchester Expressway and the New York State Thruway, for motorists moving between the New England states and points in, and south and west of, New Jersey. Study of the figures reveals that the major effect of

this extension upon traffic in the study area will be upon local roads in the vicinity of the new facility.

These data – presenting total percent diversions from the original stations – indicate the net effect the construction of three highway facilities had, or will have, upon the traffic in the survey area. It should be noted that passenger car diversions ranging from 9.4 to 92.9 percent of the original volumes are expected. These diversions will be most noticeable on local roads that frequently were heavily congested. The anticipated future connection of the New Jersey Turnpike and the New York State Thruway will result in additional changes in area travel patterns.

Construction of the facilities discussed above involved some fifty-four municipalities or boroughs, highway departments of two states, and four authorities or commissions. Since these agencies acted together, the highways were provided in a reasonable manner and serious conflicts of interest were avoided. Failure of these agencies to consider regional aspects of the problems encountered could have made it impossible to provide these badly needed facilities.

Need for Regional Planning and Control

The opening of any major highway facility through an urban area affects the development and use of land and highway facilities throughout many parts of the area. Not only are changes made in immediately adjacent highways and lands, but facilities some distance away may be affected. Because of this far-reaching effect and the fact that various governing bodies may be involved in the new construction, good regional planning and control of urban highway facilities are needed. In some metropolitan areas this objective has been attained. In other sections, an almost complete lack of planning and control on a regional basis has resulted in waste and misuse of highway funds.

Some specific ways in which regional planning and control can help an urban area are:

1. Establish the over-all highway needs of an area.
2. Eliminate duplication of effort between competing highway groups.
3. Protect individual areas by limiting major roads which traverse them.

4. Assure adequate connection between facilities.

5. Provide for adequate parking lots and terminal facilities.

6. Co-ordinate planning and construction where more than one authority or body is involved.

7. Provide a common ground for the collection of available survey data, plans and operating statistics.

8. Correlate operation of facilities to provide maximum use.

9. Assist local areas in preparing for expected changes in traffic flows and land use.

An excellent example of the type of co-operative planning needed is a 1956 survey conducted in the New York Metropolitan Area by all of its major highway agencies. These agencies jointly conducted traffic volume counts and operated forty-one origin and destination survey stations. Over one-half million interviews were obtained in a uniform manner, and analysis has been planned in such a way that data will be valuable to all participating groups and other interested parties. The end result of this concerted effort is distinctly more useful than would have been attained had each group acted independently.

In planning and construction of new facilities required to satisfy existing and future highway needs, it is hoped that careful consideration will be given to regional aspects of the problems involved. Failure of highway people to think and plan in terms of the over-all area can result in an incomplete return on the money invested. The motorist ignores political boundaries when planning regional trips; we must follow his lead.

Chicago's Fifty Million Dollar Municipal Parking Program

P. M. LINSCOTT

Since September 15, 1957, Mr. Linscott has represented DeLeuw, Cather and Company in a new branch office in Los Angeles. He has been a member of this consulting engineering firm's Chicago office since 1949. He holds B.S. degrees in Aeronautical and Civil Engineering. Mr. Linscott has participated in various types of traffic studies and directed parking studies for the Chicago Parking Program. He is a member of the Western Society of Engineers and the Institute of Traffic Engineers.

A CITY-WIDE municipal parking program was launched in the City of Chicago in 1952. Now, after five years of co-operative effort by city officials, investment bankers and consulting engineers, $41,000,000 worth of revenue bonds have been sold, financing a total of fifteen garages, sixty-two lots and 30,000 curb parking meters. The off-street parking facilities are situated in twenty-seven business districts and will provide 15,164 parking stalls.

In 1956, with approximately one-half of these off-street facilities in operation, 3,247,000 cars were parked and a gross revenue of nearly $2,000,000 was produced. Curb-meter revenues, pledged to the bond issues, produced more than $2,400,000 in 1956.

During World War II, every productive effort of the American people was directed toward the goal of winning the war. Spurred by the war, the nation developed a tremendous productive capacity. In 1945 the was ended, and immediately this huge production machine transferred much of its energy to automobile-manufacture and to development of improved highway facilities. As expressway planning and construction progressed in 1946, the need became apparent for additional parking facilities in central business districts, and particularly in the central business district of Chicago.

An important prerequisite for the planning of municipal off-street parking facilities was the formulation and passage of state legislation permitting cities to develop parking programs. The basic legislation which made possible the Chicago Parking Program was

introduced in the Illinois State Legislature in 1947 and was adopted as Section 52.1–1 in the Revised Cities and Villages Act as amended July 2, 1947.

This Act provided in part that curb parking meter revenues could be used to support municipal parking programs. This particular point became involved in considerable controversy, but the Act was tested and upheld by the Illinois Supreme Court in a case concerning the city of Kankakee, Illinois.

In 1949, the Chicago Association of Commerce and Industry, together with the State Street Council, sponsored a central business district parking study. A report made in that year conclusively established the need for additional off-street parking facilities in the Loop district. Suggested sites for such facilities were set forth, together with general cost estimates. That report provided material for top-level conferences between various city officials and the sponsoring civic groups.

Developing the Chicago Program

In the fall of 1951, the City of Chicago entered into a contract with a group of five prominent investment banking firms. This contract provided that the investment bankers would retain engineers and lawyers to develop specific proposals for parking facilities in the Loop district and further, draw the necessary ordinances and other legal papers for the issuance of parking facility revenue bonds.

De Leuw, Cather and Company was retained by the investment banking group in January 1952, and subsequently produced reports covering preliminary design, cost estimates and economic feasibility of the various parking program segments.

In the spring of 1952, during the development of engineering reports and revenue estimates, it became apparent that the Chicago parking revenue bonds could be used to provide parking facilities not only in the Loop, but also in some fifty outlying business districts. As a result of this decision by city officials and investment bankers, the basic ordinance authorizing the issuance of City of Chicago Parking Facility Revenue Bonds, was drawn as an open-end authorization for issuing Series A bonds up to a limit of $50,000,000.

Details of this ordinance are too lengthy to quote, but the basic security of the revenue bonds can be gauged by the stipulation set forth in the ordinance that annual bond service charges, which include interest costs and bond amortization, must be covered one and one-half times by the annual net revenues produced by the parking program as a whole.

The authorizing ordinance was passed in September, 1952. At that time, the first phase of the parking program was presented in report form and became the basis for a revenue bond issue totaling $22,600,000. The following table presents a summary of data covering the facilities financed by this first issue of Chicago Parking Facility Revenue Bonds:

Table 1

FACILITIES PROVIDED UNDER PROJECTS A–1 AND A–2

Area	*Number of Facilities*	*Type*	*Number of Spaces*
Central Business	3	Ramp Garages	2,554
District	2	Mechanical Garages	1,212
North Michigan Avenue	3	Ramp Garages	2,468
Area	1	Mechanical Garage	420
63rd and Halsted Streets (Englewood Shopping District)	6	Lots	1,265
Total	15		7,919

After the issuance of the first segment of Chicago parking bonds, termed "Projects A–1 and A–2," studies were almost immediately started on the second phase of the city-wide program. Again, the same firm of consulting engineers made the necessary parking studies, selected sites, and provided preliminary designs, cost estimates and feasibility report.

In this second phase, termed "Project A–3," studies were conducted in six neighborhood business districts. These studies consisted of inventory of curb and off-street parking space; usage studies of existing parking facilities, including accumulation counts and turnover studies; and general surveys to select a group of potential sites for additional parking facilities.

Figure 1. Chicago mechanical parking facility, fourteen levels, capacity of 717 cars; Wacker Drive and State Street.

Figure 2. Chicago ramp parking facility with five levels, capacity of 1237 cars; Wacker Drive between Madison and Monroe Streets.

Estimates of need for additional facilities were made, and new facilities were recommended in areas of most critical parking shortage. The studies for Project A–3 were completed in the spring of 1954 and a report published which formed the basis for issuing an additional $4,900,000 worth of revenue bonds. The following table sets forth data concerning the facilities included in this part of the Chicago Parking Program:

Table 2

FACILITIES PROVIDED UNDER PROJECT A–3

Area	*Number of Facilities*	*Type*	*Number of Spaces*
Broadway-Lawrence	1	Ramp Garage	256
	5	Lots	615
Madison-Pulaski	4	Lots	691
Lincoln-Belmont-Ashland	7	Lots	606
Roseland	3	Lots	211
Milwaukee-Ashland	3	Lots	439
47th-South Parkway	3	Lots	180
Total	26		2,998

Upon financing of the second phase of the Chicago Parking Program, the engineering firm was authorized by the investment bankers to proceed with parking studies in additional outlying business districts. These studies, made in 1954 and 1955, were presented in a report used as a basis for the issuance in May, 1956 of $13,500,000 worth of revenue bonds for Project A–4. As the following table shows, Project A–4 will provide municipal parking facilities in nineteen neighborhood areas.

Parking studies are currently being made for Project A–5, with the anticipation that additional bonds will be issued in 1958.

The first financing of the Chicago Parking Program was successfully completed in December, 1952. The first garage was completed and opened for business in October, 1954; the other facilities of Projects A–1 and A–2 were completed in 1955 and 1956. Facilities provided under Project A–3, financed in the spring of 1954, were completed and opened for business in 1956 and 1957. Facilities provided for in Project A–4 are presently under construction and will be completed and opened for operation in 1958.

Table 3

FACILITIES PROVIDED UNDER PROJECT A–4

Area	*Number of Facilities*	*Type*	*Number of Spaces*
55th-Lake Park	2	Lots	230
Devon-Western	1	Deck	195
	2	Lots	169
91st-Commercial	1	Lot	240
35th-Halsted	1	Lot	69
Roosevelt-Halsted	1	Lot	236
	1	Deck	179
47th-Ashland	3	Lots	318
63rd-Woodlawn	2	Lots	164
Grand-Harlem	1	Lot	147
	1	Deck	330
Roosevelt-Kedzie	1	Deck	178
Madison-Kedzie	2	Lots	334
Milwaukee-Diversey	5	Lots	519
Chicago-Ashland	1	Deck	213
Lawrence-Western	1	Lot	38
71st-Jeffery	2	Lots	104
Belmont-Central	4	Lots	241
26th-Pulaski	2	Lots	186
95th-Damen	1	Lot	86
79th-Ashland	1	Lot	71
Total	36		4,247

Operation of Facilities

All Chicago parking facilities except a few neighborhood lots are operated by experienced private parking garage operators through management contracts negotiated by the City of Chicago. The mayor has appointed a parking and advisory committee of prominent businessmen in the Chicago area to review the qualifications of the private operators, and approve the terms of the contracts.

The collection of revenue from the meters is handled through a private contract; the maintenance of the 30,000 curb meters is provided through a maintenance corporation contract.

Operation of the parking program is the responsibility of the department of streets and sanitation, with the parking operation handled as a part of the department's bureau of street traffic and parking. The City of Chicago also retains the engineering firm as an

independent consulting engineer to make annual inspections and report on all parking facilities in the program; to assist in preparing the budget for the division of parking; and to advise on parking rates and operating procedures.

Table IV presents a summary of operating statistics for 1956 for Projects A–1 and A–2 with the exception of two facilities which did not operate for the full year.

Table 4

OPERATING STATISTICS, 1956—PROJECTS A–1 AND A–2

Area	*Number of Facilities*	*Number of Spaces*	*Cars Parked*	*Gross Revenue*
Central Business District	5	3,766	1,578,000	$1,427,000
North Michigan Avenue	2	682	251,000	213,000
63rd-Halsted	6	1,265	896,000	152,000
Total	13	5,713	2,725,000	$1,792,000

Future of the Program

The expansion of the Chicago Parking Program is controlled by certain stipulations in the basic authorizing ordinance and in the trust indentures for the revenue bond issues. As stated before, the basic control providing a considerable measure of security for the revenue bonds is the stipulation that net revenues from the program as a whole must cover bond service charges one and one-half times. These net revenues include net revenues both from the 30,000 curb meters and from the off-street facilities.

At the outset of this program, it was assumed that facilities in the Loop would provide surplus revenue, as would the curb parking meters. It was further recognized that many of the parking lots and garages developed in outlying business districts would do well to break even – that is, to provide a coverage of bond service charges approximately once.

Thus the program could be expanded into additional neighborhood business districts until the coverage on the program as a whole was gradually drawn down to the limit of one and one-half times. At that point, additional Loop garages would have to be

developed to extend the program farther among the neighborhood areas through the medium of revenue bond financing.

New expressways are being developed in the Chicago area, creating an urgent need for additional parking facilities to serve the Loop. It is probable, therefore, that more Loop garages will be constructed, thereby paving the way to additional revenue bond financing for off-street facilities in neighborhood districts.

Expansion of the program is not limited to revenue bond financing, however. The terms of the bond ordinance are such that the surplus developed in each year can be plowed back into the program in the form of additional off-street facilities and extensions to existing facilities, so long as coverage will remain above the limit of 1.5 times.

Benefits to the People of Chicago

Many of the older neighborhood business districts have suffered business losses because of competition of new shopping centers surrounded by acres of parking space. The City of Chicago has a tremendous stake in tax values in its neighborhood business areas, and the parking program has already proved itself in holding customers and values in these shopping districts.

Subsequent to the opening of parking lots provided by the Chicago Parking Program, a general uptrend in business and a return of confidence have been noted in many areas. Store fronts have been modernized, vacant shops reopened, and buildings turned to new and profitable use. Notable among these results was the conversion of a derelict theatre adjacent to a new municipal lot into a prosperous bowling alley.

The location of parking lots in these districts is extremely important. In most cases, an attempt is made to use the parking lots as a buffer between residential property and commercial frontage. This type of location, immediately behind the commercial frontage, makes it possible for stores and shops to develop entrances and display windows at the rear of their buildings. In some cases the results are comparable in appearance and convenience to developments in the newest shopping centers.

In addition to improved conditions in business districts, the Chicago Parking Program has been applied to providing needed

off-street facilities in high-rise apartment districts. Many sites have no available space in which the private apartment owner can produce the off-street parking facility in demand by prospective tenants. In some areas, rental values have suffered severely because of parking problems, and the program can be of great help.

It is further anticipated that eventually the program can be used to assist in the "park-and-ride" aspect of rapid transit. Large parking facilities would be developed at convenient points along the rapid transit lines where people can leave their cars, avoid the traffic problems in the city, and reach their downtown destinations with a saving of time, money and nerves.

Application to Other Cities

The formula for the Chicago Parking Program can be applied equally well to large metropolitan areas or to smaller cities. Basically it consists of pooling the resources of all facilities, including curb parking meters and off-street parking lots and garages, to build a comprehensive program adequate to the parking needs of central business district, outlying business districts, and apartment districts alike.

Revenue bonds are the medium to initiate the program and to develop an earnings base that will permit the program to be carried into all parts of the community, either through additional bonds or through the return of surpluses into the extension of facilities. In Chicago in five years, this formula has paved the way for providing fifteen thousand off-street spaces in seventy-seven much-needed facilities.

Planning Our Urban Expressways

EUGENE MAIER

Mr. Maier is Director of the Department of Traffic and Transportation in Houston, Texas. Among his professional qualifications are his status as a civil engineer, his experience in highway design and construction, and in urban traffic and transportation. He is a member of the National Joint Committee on Uniform Traffic Control Devices and Chairman of the subcommittee on Channelization; chairman of the Highway Research Board Committee on Channelization, and a member of other HRB committees. He is a Registered Professional Engineer in Texas, a member of the Institute of Traffic Engineers, serving on its editorial board for the Institute's Handbook, and on the committee on traffic engineering education. Mr. Maier holds a certificate from the Bureau of Highway Traffic, Yale University.

TRAFFIC and highway engineers are faced with complex problems in the design of urban expressways in American cities, but no problem is more difficult than integration of the expressway plan with the existing urban street system. Many miles of urban expressways have been constructed during the last decade to serve the transportation requirements of many of the larger metropolitan areas. In spite of this experience, no set of principles has emerged to guide the increasing number of traffic and highway engineers charged with the responsibility of designing and constructing expressways for almost every urban area of the United States.

The completion of the interstate highway system will require the construction of expressways in states and cities where public officials and engineers have had no previous experience in either designing or operating these high-capacity traffic facilities. Expressway location and design in these areas will be further complicated by the pressure exerted to begin construction at the earliest possible date.

It would be profitable, and indeed interesting, if the expressways now carrying traffic could be evaluated in terms of their function and efficiency as part of an urban transportation system. Operational failures might be traced to lack of proper integration of

expressways with urban plans of land development and use, street systems and traffic control. In many instances, this failure to develop co-ordination was due to the simple fact that no such comprehensive plans existed.

It is not within the scope of this discussion to consider the relation of the current Federal Highway Program to urban development and the total urban transportation plan. This aspect of the problem has been ably and adequately presented by Wilfred Owens, and summarized in the following excerpt: "As the United States has become progressively more urbanized and motorized, a closer relation between transportation and urban development has become essential. We will have to plan transportation facilities to achieve better communities and community planning will have to be designed to achieve better transportation. The new highway program, broadly conceived, can launch a revolutionary attack on metropolitan problems that is long overdue."[1]

Mr. Owens also points out: "A substantial program of highway construction will be completed within the metropolitan areas of America during the next decade, with or without plans that can furnish an urban environment in which the highway program can most effectively serve."

This fact presents a real danger to communities and their citizens. Although necessary and comprehensive planning for land use control and urban redevelopment may not keep pace with the highway construction program, many mistakes can be avoided or minimized if those charged with administering the program understand the basic principles and concepts involved.

Function of the Urban Expressway

The development of an efficient urban expressway requires more than the putting together of such elements of expressway design as through-lanes, merging and weaving areas, ramps, emergency stopping lanes and interchanges, which the designer expects will be capable of accommodating traffic demands twenty years hence. Rather, the designer is developing one element of an urban trans-

1. *The New Highways: Challenge to the Metropolitan Region*, Connecticut General Life Insurance Company.

portation system that, by its very nature, exerts a tremendous influence on the urban complex of business, property, and most important, people.

The influence will be beneficial if the designer understands and appreciates the function of an expressway as part of a total street network. Conversely, serious and permanent damage can be imposed upon an urban area if the designer considers the expressway only as an efficient means for moving rural traffic through an urbanized area over a system of inter-state highways.

The urban expressway, considered only as a traffic artery, serves several important functions. It handles extraordinary volumes of traffic with a high degree of safety. It more adequately serves users' travel-time desires. It overcomes handicaps in the present street network. And, most important, it relieves existing major arterial streets of excessive traffic.

In spite of this importance, and contrary to the belief of many public officials and citizens and some engineers, the urban expressway system alone will not solve the urban transportation problem. It will, however, through its single purpose of moving heavy volumes of traffic at high speeds over long distances under conditions of controlled access, divert a substantial volume of traffic, foreign to the economic needs of the area, from the street network of the area it traverses.

This diversion of through-traffic will permit an upgrading in the operational efficiency of the major arterial system which is the backbone of the urban street network. In Los Angeles a traffic-distribution estimate indicating that sixty percent of the total traffic traveled on the major arterial system as compared with nine percent on the freeway system emphasizes the importance of both the expressway and major arterial street systems to the total transportation needs of the urban area.[2]

Developing an Expressway Concept

Although comprehensive urban plans may not have been sufficiently detailed to provide a rational expressway plan, a prelim-

2. K. A. Stonex, *Survey of Los Angeles Traffic Characteristics*, presented at the 36th annual meeting of the Highway Research Board.

inary concept of expressway location and operation should be developed at the earliest possible time. This concept often will require decisions that can be based only upon experience and judgment, but it is far better to make them prior to actual expressway design and construction than to develop the expressway system on a piecemeal and unco-ordinated basis.

The preliminary concept should include a plan for regulation and control of traffic that will use this network of high capacity urban highways. When expressways are first opened for public use, traffic volumes are usually low in comparison to design capacity and operational problems are generally few and simple. However, as traffic volume approaches and exceeds design capacity, traffic regulations and controls must be established to assure efficient and safe operation. These must be considered during the earliest stages of planning for they influence to a considerable and important degree the expressway design.

For instance, if it is in the interest of the total transportation needs of the community to provide for operating express transit buses on the expressway system, as most certainly it should be, this decision is a significant factor in the expressway design. Efficient transit operation on expressways is an element of design and cannot be added as an afterthought when the need for such transit service becomes more clearly apparent.

As a minimum, land use studies and origin and destination surveys normally are available to the expressway planner. The traffic-generating characteristics of existing land use and the desire-lines of travel will provide the preliminary expressway framework. Major desire-lines will radiate from the central business district and connect with important state and federal highway routes approaching the metropolitan area. Major crosstown movements will form segments of a series of partial or complete loops.

In the larger metropolitan areas, the innermost expressway loop will surround the core of urban development. This expressway loop – as close to the central business district as the many complex factors influencing its location will permit – serves the important functions of integrating and providing interchange between the radial expressways, assuring the most efficient interchange between the freeways and central business district, and diverting through-traffic

from congested streets of the business district. This last factor is most important for it is usually the only means for recovering traffic capacity on the street network required to support the intense developments within the core of every metropolitan area.

A 1953 origin and destination survey of the Houston metropolitan area revealed that of all traffic crossing a cordon adjacent to the central business district, seventy percent was through-traffic. Completion in 1956 of only a short segment of the proposed loop expressway (Figure 1) reduced the through-traffic to sixty percent; it is estimated that completion of the loop will further reduce the volume of through-traffic to approximately twenty or twenty-five percent. This diversion of through-traffic will permit the continued free flow of traffic in the business district.

As an example, the expressway plan for the Houston metropolitan area is shown in Figure 2. Planning for the system began in 1946. From that date until 1956, during which time the city was required to furnish all rights-of-way, the right-of-way for the expressway system was protected by established building lines to prevent building construction along these proposed routes. Considerable sums of money were spent by the city in the program. The wisdom of this early planning is now apparent; expressway routes that would have been lost because of building construction are now available for the current Federal Highway Program.

Superimposing Expressway Concept on Urban Complex

The most difficult and complex phase of urban expressway planning is reached when the preliminary concept is superimposed upon the urban complex as it is today and as visualized twenty or thirty years hence. During this planning phase, questions will be raised by elected officials and public administrators at each level of government having an interest or responsibility in the development of the plan or its outcome. To what extent does the proposed plan meet the total transportation needs of the community? Does the plan exceed minimum transportation needs or has it been combined with other community plans for land use and urban redevelopment? How will excess costs, above minimum needs, be apportioned and financed? What is the impact of the plan on existing urban development? Will it contribute to blight?

Figure 1. Aerial view of Houston central business district and a section of inner-loop expressway.

Answers to these questions, and a hundred more, will establish conflicts of interest among the several agencies of government that seek a solution for pressing problems of urban transportation. On

Figure 2. Freeway system for the Houston metropolitan area.

the one hand, federal and state highway administrators are undertaking the difficult assignment of completing for the states and the nation an integrated and modern system of highways, the most important sections of which are located within congested urban areas. Pressures are being exerted to complete the program at minimum costs and in a reasonably short period.

At the same time, local officials must exercise vigilance and understanding to assure that highway planning brings into proper focus the relationship between a proposed highway project and the area through which it is to be constructed. Primary responsibility in this area of transportation planning rests with the city official. He alone understands the planning objectives of the community and he must assure their consideration and integration in urban highway planning by co-ordination and co-operation with the highway engineer.

Unfortunately, however, the Federal Aid Highway Act of 1956 provides no reasonable basis for negotiating and resolving the inevitable conflicts of interest at all levels of government. This omission in the Highway Act, however unfortunate, must not be permitted to interfere with the essential program of highway construction directed by the Congress. Although Congressional action will eventually be required to define more clearly the responsibilities and interests of each level of government, a clearer understanding of the objectives of the urban highway program now will contribute to a better appreciation of the co-operation and co-ordination required of all agencies and individuals.

Factors Limiting Expressway Designs

Only after agreement has been reached on the preliminary concept and location should geometric designs be developed for any segment of the expressway system. The geometric design will require consideration of three important principles:

1. *The traffic design of each separate segment of the entire expressway system must be in balance.* Balance can be achieved only by a consideration of the *entire* urban expressway plan. Piecemeal design will result in operational deficiencies at critical locations that will reduce proportionately the operating efficiency of the entire system. A review of existing expressways reveals locations where *two* three-lane expressways plus a one-lane entrance ramp have been merged into a three-lane expressway. Or, where a three-lane expressway provides no added width at an interchange where an entrance ramp operating at capacity joins the expressway. Such design failures can be eliminated only by developing, insofar as

practical, the traffic design of the entire urban expressway system before preparing construction designs for any section of expressway.

2. *The expressway must be integrated with the major arterial system so that there will be proper traffic balance between the two street systems.* A projection of 1975 traffic along a particular desire line may indicate the need for an expressway capable of accommodating 200,000 vehicles per day. The construction of such a facility would be unrealistic unless it could be demonstrated that the traffic design was in balance with the capacity of the major arterial system.

3. *A maximum expressway cross section should be adopted which assures an acceptable level of safe and efficient operation during periods of peak traffic flow.* Insofar as practical, expressways should be limited to a maximum of three lanes of moving traffic in each direction. Expressway widths of four or five lanes in one direction should be developed with extreme caution and only for short distances in areas where weaving movements are minor.

'Unrealistic and Restricted'?

It may be argued that the application of these design principles to an urban expressway is unrealistic and too restrictive in view of present traffic needs, and the estimated 1975 traffic demands based on expansion of origin and destination surveys. The three principles are set forth on the premise that a practical maximum traffic volume can be assigned to a single axis and superimposed on an urban area and at the same time balanced with the capacity of the arterial street system.

Excess design capacity on an expressway will develop interchange movements at major arterial crossings that seriously and adversely affect the ability of the arterial to accommodate both interchange traffic between the expressway and the arterial and the normal arterial traffic moving transverse to the expressway. Under these conditions inefficient interchange occurs between the expressway and arterial street systems, and the overall traffic capacity of the arterial system is reduced because of the traffic bottlenecks at expressway crossings.

Some may object to these principles on the basis that a too close spacing of expressways will result or that, at some future date,

additional expressway routes will be required. Such a circumstance need not arise if communities control urban development to maintain proper relation between traffic-generating characteristics of the area and the traffic capacity of a balanced expressway-arterial street system.

Admittedly, situations will obtain, particularly in the urban complexes along the eastern seaboard, in which traffic needs will exceed the design capacity of a six-lane expressway. Under these conditions, the "dual-dual" type expressway offers a most practical solution.[3] For the most part, however, the greatest mileage of urban expressway will be constructed under conditions where effective urban development controls will maintain proper balance between the traffic demands on an expressway route and the traffic capacity of the arterial street system.

Interchanges and Frontage Roads

When agreement has been reached by all agencies of government concerned, preliminary geometric designs will provide details of the expressways and their connections with the arterial street system. In the area outside of the central business district, the problem resolves itself into a consideration of those factors that establish the cross section of the expressway and the location of interchanges.

If the expressway is to serve the needs of the urban area, interchange will be required, as a minimum, at all arterial streets, usually spaced at approximately one-mile intervals. Separation of grades will be required at crossings of secondary or collector streets normally situated midway between arterial streets. At some of the more important crossings of the secondary street system, particularly in business and industrial areas, interchange movements must be provided in the expressway design.

Frontage (service) roadways adjacent to the expressway will be required to maintain access to abutting property where such access existed prior to the expressway location. However, serious and valid objections can be directed toward a policy of providing continuous frontage roads where they are not required to provide essential

3. Ralph L. Fisher, "Designing Roads for High Capacity," *Traffic Quarterly*, April, 1957. Eno Foundation, Saugatuck, Connecticut.

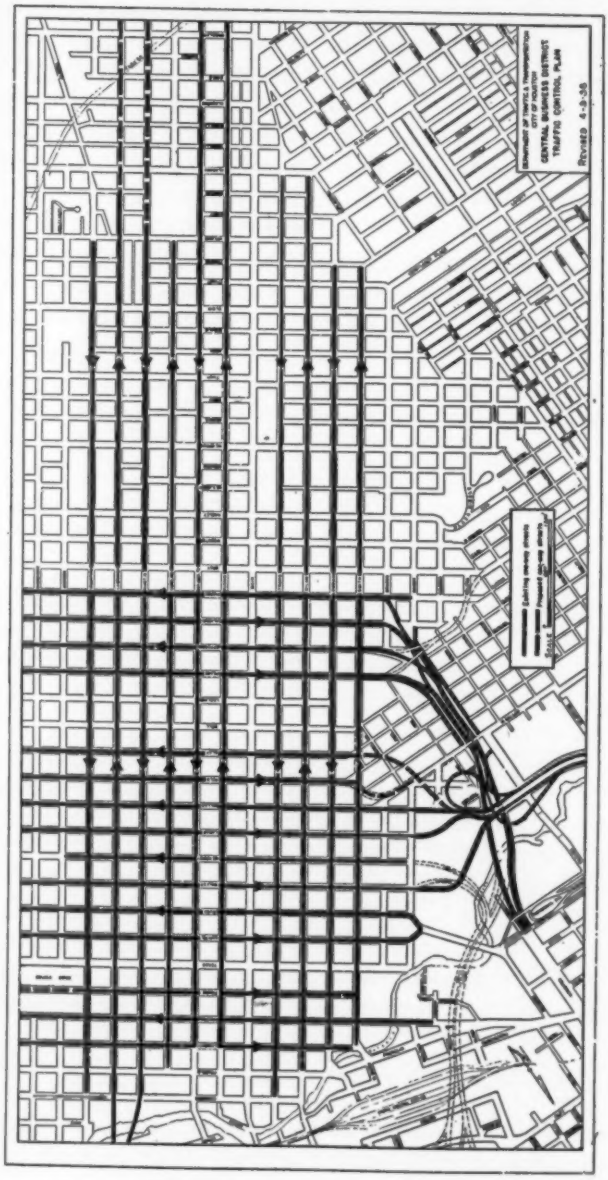

Figure 3. Houston's central business district traffic control plan.

access to abutting property. Although continuous frontage roads simplify the administration of an urban expressway program by removing controversies relating to access, the policy greatly increases the cost of right-of-way and construction and, at the same time, adversely affects the safety and efficiency of the expressway. Continuous frontage roads are, in effect, arterial streets adjacent to an expressway. Substantial local traffic volumes are generated on these roadways by the intense commercial and industrial development of adjacent property and by the diversion of traffic from nearby, congested arterial streets.

The most serious and adverse effect of the continuous frontage road is that this arterial street traffic, not related to expressway operation, is mingled with traffic leaving or preparing to enter the expressway. This procedure normally takes place at an interchange with an arterial street and places demands on the capacity of the interchange (normally operating under traffic signal control) that cannot be accommodated. A serious bottleneck is produced on the arterial street system, and the efficiency and balance of the entire urban street network is jeopardized.

Where frontage roads are required to provide essential access, traffic should be restricted to one-way movement. If two-way movements are permitted, operational problems at interchanges reach impossible proportions.

Traffic Control Plan

The integration of expressway geometric design with the street system and traffic control plan of the central business district is most complex because of the extremely high traffic volumes during morning and evening periods of peak traffic flow.

The first essential consists of a traffic control plan for the area within the inner expressway loop or to the point where the expressway begins. The traffic control plan for the central business district of the City of Houston (Figure 3) typifies action that must be accomplished prior to any expressway planning. This plan, initiated in 1948, provides for traffic regulation and control to develop the full capacity of all streets within the central area. In devising the plan, no particular consideration was given to existing traffic move-

ments on the theory that eventual development of the area would require all streets to operate at or near capacity and that traffic demands would balance with available capacity.

The plan provides for a complete network of one-way streets with a modern traffic control system. Other traffic regulations – control of curb lanes, turn restrictions, double turns, etc. – are established as required to maintain a balance in the traffic capacity of each block.

Traffic within the area is controlled by a modern, variable frequency traffic signal system. During the off-peak traffic periods signal cycles vary from forty to fifty seconds, and the one-quarter cycle off-sets between intersections permit progressive traffic flow at speeds of eighteen to twenty-two miles an hour. Traffic speed is varied in proportion to the density of traffic flow within the signal system. In spite of tremendous increase in CBD traffic during the last decade, and even though seventy-eight percent of all trips to the business district are by private motor vehicles, traffic is still able to move during off-peak traffic periods on any street through the area without stopping.

When the density of traffic increases during the morning and evening peak-traffic flow to the point where the speed of moving traffic is less than eighteen miles an hour, the system automatically changes to simultaneous signal operation and a cycle length of seventy to eighty seconds is selected as required. This method of signal timing provides the most efficient operation during periods when large volumes of traffic are being unloaded from parking lots and garages.

The established traffic plan for the central business district provides an essential basis for design of the inner expressway loop. To date, only a small segment of the loop expressway has been completed along the west side of the business district. Although completed in January 1956, this expressway section will be inadequate when the proposed extension to the north is completed.

Integrating CBD Traffic Control with Expressway Loop

The design of urban expressways is a responsibility of the Texas Highway Department. The department has not as yet completed

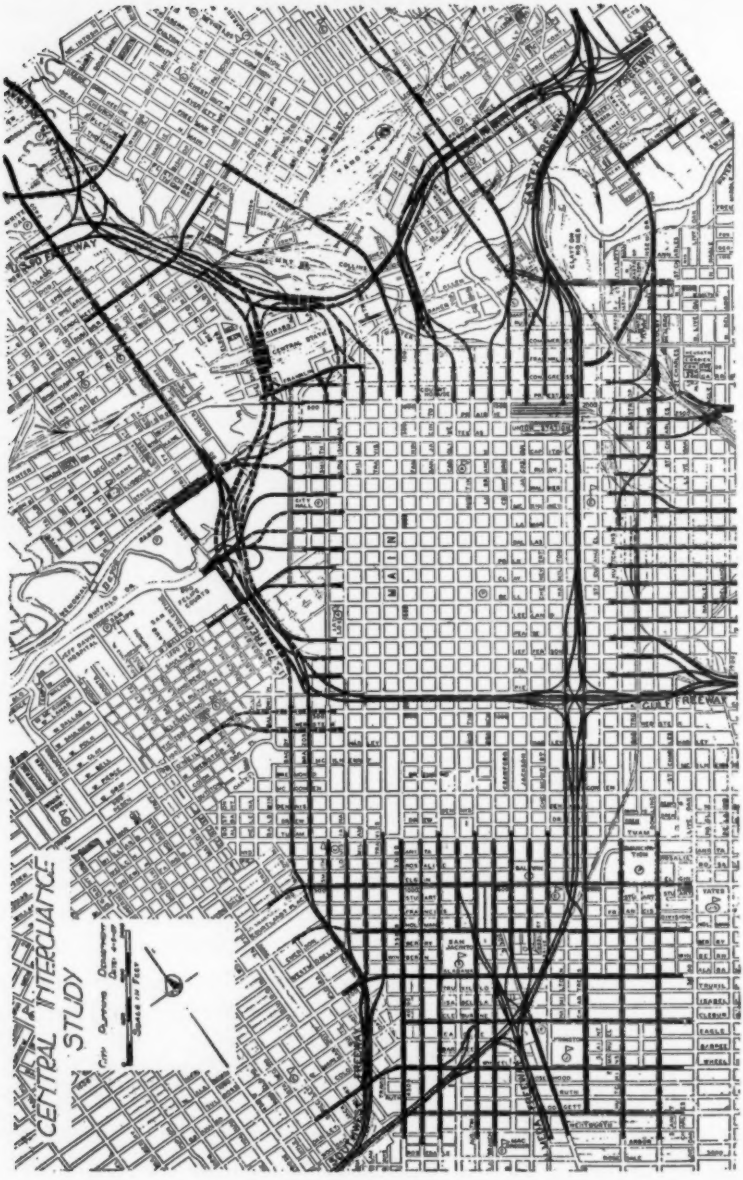

Figure 4. Design study for integrating an expressway system with Houston's CBD.

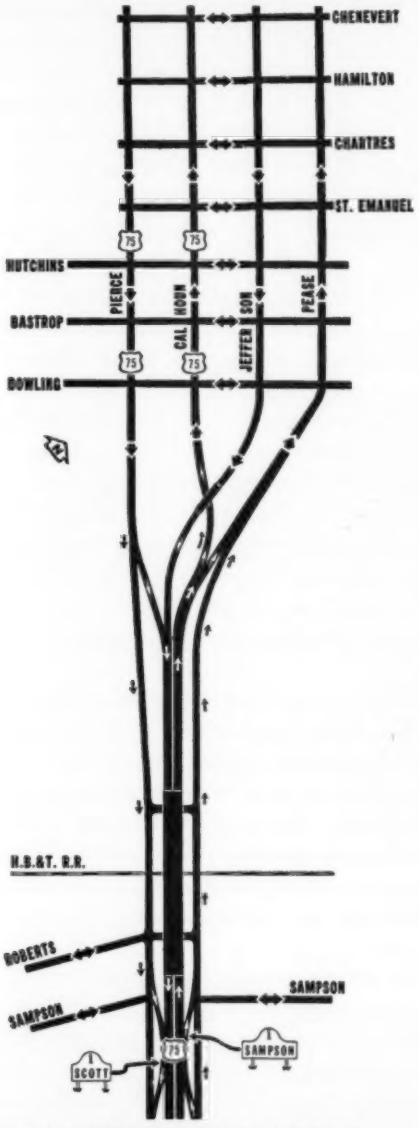

Figure 5. Traffic distribution between expressway and Houston's CBD street system.

the design of the inner loop expressway, but a design study developed by the City of Houston (Figure 4) offers an example of the principles of integrating an expressway system with the central business district. The design study provides for the connection of each radial expressway with a minimum of four one-way streets.

This method of distribution of traffic between an expressway and the CBD street system is now in operation at the terminus of the Gulf Freeway (Figure 5). The present average daily traffic volume on this expressway is approximately 100,000. During the morning and evening peak-traffic flow, the freeway operates above practical capacity. The feeder or distribution street system adequately served the freeway until the average daily traffic reached approximately seventy-five to eighty thousand, but the present freeway volumes exceed the system's capacity. The completion of the expressway loop will divert sufficient traffic from the feeder streets to permit satisfactory operation during peak periods.

In the design study, each street in the central business district connects with an expressway or major thoroughfare and assures that the entire potential capacity of the area's street system is realized.

Transit on Expressways

Studies conducted by the department of traffic and transportation indicate that the only practical means of improving or even maintaining the present public transit service is by operating express buses on the expressway system. The city has engaged consultants to study requirements for an urban bus terminal to be located in the central business district. This terminal would be in the proposed transportation center designed to integrate all forms of transportation – rail, inter-city bus, suburban express bus, local bus and helicopter.

Planning for the proposed bus terminal must be co-ordinated with expressway planning since interchange between the inner loop expressway and the terminal would be required for efficient operation. Further, it is expected that the study will provide a basis for negotiating with the Texas Highway Department a policy relating to bus operation on expressways. The present department policy recognizes the need for buses on expressways, but requires that

buses leave the expressway for loading and unloading of passengers. The normal arrangement of expressway ramps, even with continuous frontage roads, precludes a reasonable express bus operation under the present policy.

The current urban highway construction program presents an unprecedented challenge to those charged with administering the program and to the public officials in every American city now striving to stem the growing traffic congestion which threatens the integrity and advantage of an urbanized society.

In spite of the announced objectives of the program, growing concern is evident among sincere public officials that the program is being advanced without due regard for planning objectives and needs of the communities to be served. Essential integration of highway and urban planning can be achieved only in an atmosphere of co-ordination and co-operation. Unfortunately, and regardless of the good intentions of the individuals involved, co-ordinated and acceptable solutions will be reached only within the framework of legally established safeguards. Pending enactment of this essential legislation, cities must move quickly ahead and develop a comprehensive urban transportation plan, or the highway engineer will be forced to construct urban expressways in an atmosphere of uncertainty and potential error.

The highway engineer must recognize the urban expressway as an element of the total urban street network and strive to achieve a balance of design that will assure efficient and safe operation. The city official must face up squarely to the responsibility of developing the remainder of the urban street network – the arterial, collector and local street systems – to those standards of design and operation that will assure the levels of service required to support the expressway system and prevent early obsolescence of the total transportation system and the urban area it is intended to support.